

# SAE JOURNAL



MAY 17 1947

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MAY 1947

In this issue . . .

**AERONAUTIC**  
Meeting  
Coverage



# Rumor Page



## IT'S RUMORED THAT

**The Indianapolis 500-mile race will be broadcast again this year!**

True. Tune in for thrills and chills, Mutual Network, Memorial Day, May 30. Four broadcast periods: 9:45-10:15 a.m., 11:15-11:30 a.m., 1:00-1:15 p.m., 2:00-2:30 p.m., CST. Sponsored by Perfect Circle, dedicated to automobile mechanics everywhere—America's Doctors of Motors.



## IT'S RUMORED THAT

**The 1948 Studebaker will have reversible seats and fore and aft controls!**

"Sorry," smiled K. B. Elliot, Vice-President in charge of Sales and Advertising for Studebaker. "Although our 1947 model is quite an innovation and has provoked much comment (which we don't mind), I'm afraid that rumor is slightly far-fetched."

*Contributed by Alvin Kagan,  
Bridgeport, Conn.*



## IT'S RUMORED THAT

**8,875,000 bottles of pop have been consumed at the Indianapolis races!**

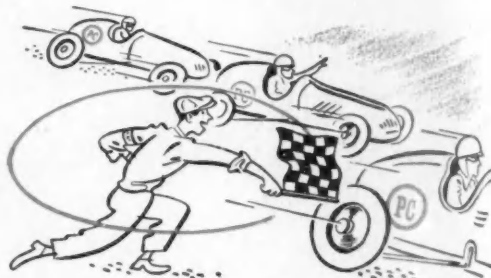
True, according to Herman Deupree, unofficial statistician of the 500-Mile Races. Also over 6,000,000 hot dogs, eaten during the past 30 runnings of this exciting race.



## IT'S RUMORED THAT

**51 out of 57 cars finishing 1, 2, 3, in past Indianapolis races were PC-equipped.**

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## The Cover

● Twin nosewheel installation of Lockheed's Constellation, shown on our front cover this issue, uses a 34 x 9.9 wheel and tire.

Camber is set at approximately 6 deg. The entire assembly is retracted when in flight presenting a smooth contour along the entire length of the unusually long strut assembly.

# For the Sake of Argument

By NORMAN G. SHIDLE

Everybody gets yens to write letters to editors. An amazingly large number of people gratifies that yearning at least once. With some it becomes a habit - occasionally a career.

Down deep in their hearts, editors *like* to get letters from readers. They like bouquets better than brickbats - but vastly prefer brickbats to nothing. As professional editors, they like evidence of any kind that readers are reacting to what they read.

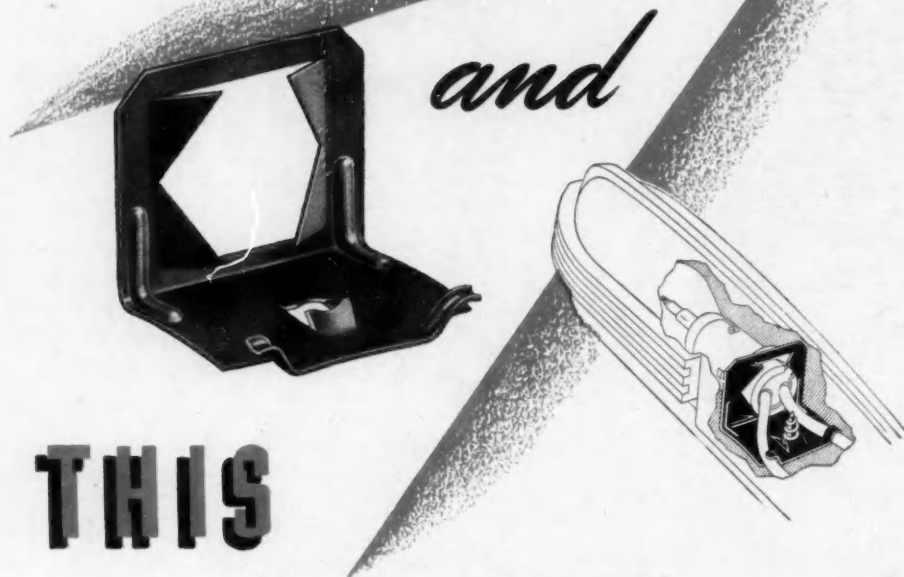
Any letter to a newspaper or magazine falls into one of two categories:

1. It is one man's idea - expressed on the assumption that his own problems are the center of the universe. It is entirely subjective.
2. It takes into account the other fellow's problems and aims; reasons objectively. The writer sees himself as one of many - in perspective.

The subjective letter is useful as a statistic. It influences editorial thinking only if a great many others express exactly the same idea. Experienced editors know that it is the percentage that counts in the long run - rather than the vigor of the particular comment. Good editing means watching and being guided by the percentages, so far as these purely subjective reactions are concerned.

Objective letters get more individual attention, because the ideas are expressed in terms which make them applicable to existing conditions.

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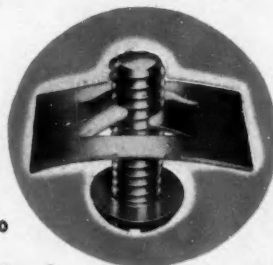
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## SAE Speaks of Itself . . .

Since establishment last year of an SAE Public Relations Committee, SAE work in this field has moved steadily toward objectives detailed by the Committee.

Public relations effort at SAE tries to strengthen and broaden understanding of Society and member activities. Special attention is directed to areas where such understanding can bring useful appreciation of the value to industry and to individual engineers of SAE meetings, publications, and technical committee work. Particular effort is made to keep industrial executives well informed.

Dignity and economy are required characteristics for every SAE public relations operation. . . Letters, speeches, publicity releases, interviews with prominent members - these and many other devices are used regularly within the limits of a modest budget. The SAE Technigram - a periodic, brief report to leading executives throughout the automotive field - is a typical element in a practical program.

As time goes on, your Committee hopes to increase the skill and effectiveness with which it uses each of its public relations tools.

Chairman, Public Relations Committee

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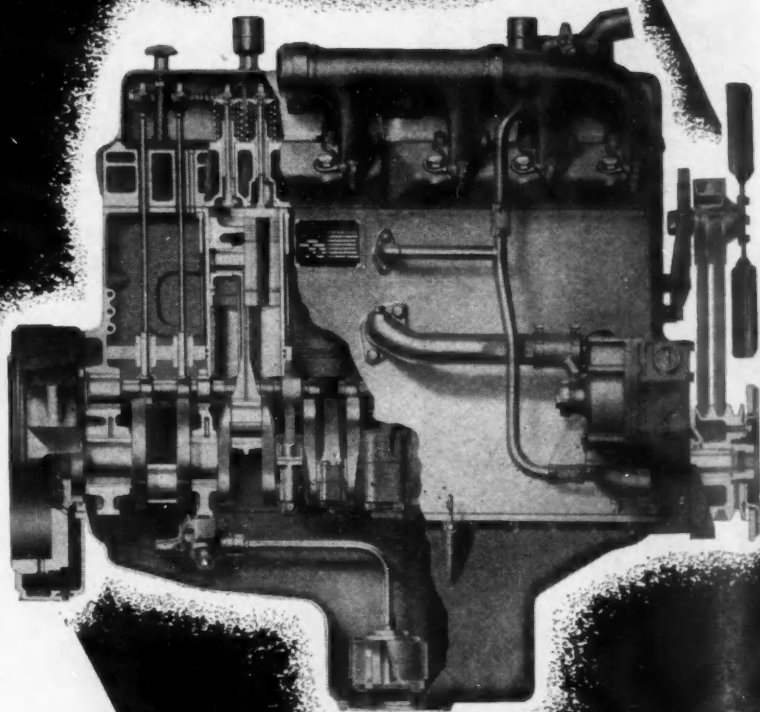
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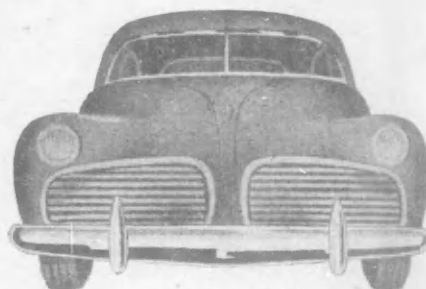
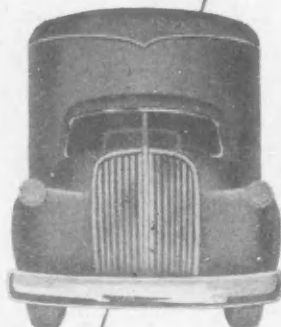
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**Ever Built**

**Automotive Vehicles**

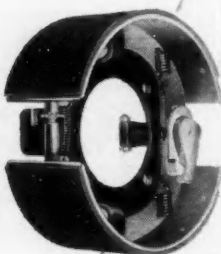
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# ■ Constitution Revisions Proposed

■ By **GEORGE A. DELANEY**

Chairman, Constitution Committee

Proposed SAE Constitution revisions, due for first reading and discussion at French Lick in June, have three major aims:

1. To permit improvements in operation of SAE's administrative and committee structure;
2. To give Constitutional recognition to desirable practices which have become established since the last general revision was made in 1932;
3. To modify the language where necessary to express ideas more clearly, to make it possible to read only one meaning into any provision.

The Constitution Committee's final proposals bear out the prediction made in my brief January SAE Journal message that "no major revisions seem likely to be suggested."

Typical of changes aimed at more flexible operations is suggestion that naming of specific committees be removed from the Constitution and Council's committee-appointing powers be expressed simply and broadly in a single provision that it may appoint such committees as it finds necessary to assist it . . . and that it may define the scope and authority of the committees in By-Laws or otherwise.

Under the new provision, Council would presumably appoint all the technical and administrative committees, such as membership, meetings, publications, Technical Board, and so forth, which now serve useful functions - but would be free to discontinue such an obsolete

group as the House Committee without having to change the Constitution to do so.

Three of the 34 proposed changes are required to gain this single objective.

Because experience has indicated there is need for a semi-annual business meeting only occasionally, your Committee proposes to eliminate the Constitutional provision requiring such a meeting . . . leaving the Council or the members with power to call a special business meeting of the Society at any time or place should need arise in the interim between the Annual Business Meetings. The requirement for an Annual Business Meeting would be retained in the Constitution, however.

Vast majority of the 34 changes proposed are aimed simply at clarification of existing language or intent. In this category are the changes which define the grades of members entitled to hold

Society offices and define the voting rights of each grade of member; which redefine the qualifications for Associate as distinct from Member grade; which provide transfer from Service or Foreign to Member grade only upon application; which makes Foreign Members eligible for Life Membership; and which delete the words "on a National basis" from certain provisions because the SAE now is international in scope. Another proposed change clarifies the provision that delegates-at-large

## ■ AVAILABLE NOW

Complete text of proposed revisions to the SAE Constitution will be mailed to any SAE member on request.

The proposed revisions will have their first reading at the Summer Meeting Business Session at French Lick in June. Stimulation to develop these proposals came from the Advisory Committee to the Council which has studied the whole SAE structure in relation to post-war functional needs.

This article by Chairman Delaney highspots the suggested revisions and indicates the basis for many of the proposals.

to the Annual Nominating Committee shall be voting members of the Society. In none of these and similar proposed changes is any essential change made in the rights and privileges previously enjoyed by members, the revisions being confined, it is believed, to clarification of situations which previous language left slightly or considerably obscure.

Among changes proposed to give Constitutional recognition to desirable practices which have grown up in recent years, one to permit payment of initiation fees in installments is typical. Others which might be included in this category are transfer from By-Laws to the Constitution of provisions for nominating SAE vice-presidents; recognition of SAE Groups as official units in the SAE structure; and inclusion of a previously-lacking specific authorization procedure for adoption of By-Laws.

Several proposed changes are such as could

make some specific difference in individual member relationships with the Society. Tops in this category is proposed elimination of Affiliate Member and Departmental Member classifications. The Committee urges these eliminations because "the Society is primarily an organization of individual members . . . and Affiliate members do not participate in SAE activities except through Affiliate Member Representatives whose rights and privileges are limited. . ." Departmental Members have never been numerous (there are but 9 at present) and the small use made of the grade indicates its obsolescence.

Another proposal would make a delinquent member not entitled "to receive any publications or other services from the Society for the period of his delinquency"; and still another would permit Council to expel any member of any grade by a three-quarters vote of its elected membership . . . instead of by unanimous vote as now provided.

## By-Laws Revision Task Is Assigned

**T**O bring SAE By-Laws in line with provisions of the proposed revised Constitution of the Society, the Executive Committee of the Council has been assigned the task of modifying the present document.

Some of the revisions suggested in the proposed revisions of the Constitution make changes in the present wording of the By-Laws advisable. The two documents must be consistent.

For example, in connection with establishing SAE committees, certain mandatory provisions have been deleted from the proposed Constitution. These call for new By-Laws clauses.

Recommendations made will be submitted to Council for action.

Members of the Council's Executive Committee are SAE President C. E. Frudden, C. H. Miller, A. J. Blackwood, J. M. Crawford, and L. Ray Buckendale.

**SAE National**

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**(Spring)**

**MEETING**

**O**UTSTANDING technical papers dramatically forecast the role of engineers in a world desiring peace and conscious of national security at the SAE National Aeronautic Meeting (Spring) in New York, April 9 to 11.

While smaller than at war-year meetings, audiences again proved the sincere desire of foresighted engineers to work together for more rapid solution of the multiplying problems which today's aeronautical development faces.

Those present learned that:

- Long-sought reliability and economy of tomorrow's aircraft will be achieved through better design of components.

- The Jet Age has dawned, but for the next decade reciprocating engines will continue to be the powerplants of the industry.

- The U. S. Navy will continue to operate land planes, probably jet-propelled, from strategically-located carriers in event of war.

- Automatic controls increasingly are supplementing, even supplanting, human energy in aircraft.

- Large-scale operation of sky-freight may be expected by 1950.

- Aircraft may be designed within an envelope of engineering, operational, and Governmental requirements.

- Congress should establish a national aviation policy which will perpetuate an aeronautical industry adequate for peacetime needs, and reasonably adequate for wartime demands.

The last point was forcefully made by Major-Gen. Oliver P. Echols, USA (Ret.), president, Aircraft Industries Association of America, Inc., who spoke at the dinner which closed the three-day meeting Friday night.

As commanding general of the AAF Matériel Command during the war, Echols was responsible for the largest dollar volume – and unquestionably the most complicated group – of war contracts of any man in history.

In a review of the technical problems faced by the engineers of the industry, he pointed out that instruments, wings, fuselages, configurations, and propulsions are undergoing vast changes.

"Aerodynamically and structurally airfoils, too, are undergoing a revolution and are piling up a formidable engineering task.

"New wings are so thin that entirely new methods of construction must be developed. New alloys and other materials will be needed.

"Working in the compressibility of the sonic ranges, these new structures must withstand greatly increased strains and pressures.

"To further complicate the engineer's task, these new thin wings force redesign of landing gear, since conventional types cannot be retracted within the thinner wings, and fuel tanks and all other components involved must also be redesigned.

"Flying wings, swept-back wings, diamond-shaped wings, and shapes yet to be thought up must be investigated and perfected," he pointed out.

Industrial, Army, Navy, and civilian engineering leaders of the industry were honored guests at the meeting. Introduced by William E. Conway, chairman of the Metropolitan Section, Toastmaster W. J. Blanchard, general manager of

Aeroproducts Division, General Motors Corp., introduced the guests, President C. E. Frudden of the Society, and General Echols.

An exhibit of equipment currently used in instrument flying was made available to the Metropolitan Section Exhibit Committee by Eclipse-Pioneer Division, Bendix Aviation Corp., Federal Radio & Telephone Co., and four airport models made available by the CAA and a fighter ejection cockpit designed by Chance Vought Division, United Aircraft Corp., and a bomber cockpit by

Glenn L. Martin Co. These cockpit mockups were also used during the meeting to illustrate a paper by a U. S. Navy officer.

Chairman of the Metropolitan Section Exhibit Committee was J. O. Charshafian, Wright Aeronautical Corp.

Thirty-three authors and co-authors prepared the 24 papers presented at the five Aircraft, four Aircraft Powerplant, and the three Air Transport Sessions, reports of which follow.

# AIRCRAFT

## Increased Reliability, Lower Cost, Are Stressed

**T**OMORROW'S airplane will achieve long-sought reliability and economy through better design components, engineers at the five aircraft sessions reported. They showed how concentrated re-engineering attention to instruments, power-driving devices, structural materials, landing gears, and accessories already is attaining projected dependability and low cost objectives.

Examination of this "composite" airplane of tomorrow discloses use of a new graphical analysis method of preliminary design that determines the most efficient combination of variables.

Changing one of a group of variables—such as stall and cruising speeds, take-off and landing distance, and range—may affect others in the group, it was said.

This design technique evaluates improvements in one item of performance in terms of other abilities so that the best compromise can be reached readily.

Structural designers who must convert this "paper" plane to a producible machine were shown how use of the new high-strength aluminum alloy, 75ST, can save considerable weight, provided both the material's advantages and limitations are known.

While 75ST, replacing presently-used 24ST, can reduce the weight of sections by an average of 25%, these savings are not always realized. In a compression stiffener critical in buckling, saving weight with 75ST would reduce stiffener strength. Designers were advised that greatest weight saving and strength increase will be achieved in compression columns in the short column range.

Spotlighting landing gear, one expert said that our heavier plane of tomorrow, with wing stow-away space at a premium, demands more than design approximations for lighter, longer-life wheels. He told designers that experimental stress analysis using brittle lacquer—Stresscoat—will reveal the critical and dynamic loadings as experienced in actual landing.

Climbing into the cockpit of our "dream air-

Based on ten papers presented at five Aircraft sessions, under chairmanship of C. V. Johnson, J. M. Shoemaker, A. E. Raymond, R. C. Bergh, and C. N. Colvin . . . "Use of 75ST in Structural Applications," by George Snyder and F. J. Crossland, Boeing Aircraft Co.; "The Experimental Determination of Strains in Aircraft Landing Wheels and Brakes," by M. H. Polzin, Goodyear Aircraft Corp.; "An Approach to the Analytical Design of Aircraft," by A. B. Croshore, Jr., and H. H. Cherry, Douglas Aircraft Co., Inc.; "A Longitudinal Control System for High Speed Aircraft," by H. O. Wendt, Curtiss-Wright Corp.; "Design Features of the Martin 202 Hydraulic System," by E. G. Riley and T. C. Hill, Glenn L. Martin Co.; "Some Applications of Hydraulics to High Speed, Rotary Drives for Aircraft Accessories," by W. W. Thayer, Douglas Aircraft Co., Inc.; "Hermetically Sealing Aircraft Instruments and Control Components," by W. A. Reichel, Kearfott Engineering Co.; "Aircraft Engine Starters," by Ralph Heintz, Jack & Heintz Precision Industries, Inc.; and "Development of Functional Cockpits for Naval Aircraft," by Com. Norval Richardson, Bureau of Aeronautics, Navy Department; "The Development of Naval Aircraft," by Rear-Adm. L. C. Stevens, Bureau of Aeronautics . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

plane," we find controls arranged for easy, efficient operation. (This isn't the case today.) According to a Naval officer who both flies in, and designs cockpits, "confusion in the cockpit" nullifies the safest and most economical airplane design.

Carrier operation will remain the backbone of naval aviation, declared another high-ranking Navy officer. (An article, entitled "Naval Air Power—Its Past, Present, and Future," based on his paper, is on p. 30.)

Warming up our airplane of the near future for a trial flight, we are told that its starter packs a lot of power in a light-weight package. This compact design, said its designer, is built with a magnesium base, weighs only 22 lb, and can start an R-4630 engine.

Modern electrical and mechanical engineering—such as addition of interpoles to motor and elimination of flywheel to get direct instead of inertia starting—cut weight and increased reliability.

Winging through the sky in the "composite" airplane, our pilot will experience greater high-speed reliability using easier-handling controls—a new spring-tab elevator system combined with feeler elevators, or feelevators. According to its creator, the feelevator is actually a second elevator

that stabilizes stick force as airspeed increases.

Back on the ground after our trial spin, we might examine the instruments on the hypothetical plane's panel. They are protected from externally caused failures by an airtight sealed package. This recently developed technique, it was said, gives glass-to-metal and metal-to-metal seals and permits adjustment without breaking the seal.

Importance of this development was pointed up by Navy war records, indicating that 95% of electrical equipment failures in the Pacific were due to dirt, dust, fungus, and salt air. Hermetically-sealed instruments will require only one-twentieth the normal servicing.

Climbing out of the cockpit and into the fuselage

A—Howard Coonley, executive vice-president of the American Standards Association (left), with Admiral J. F. Farley, commandant of the U. S. Coast Guard, and P. R. Bassett, president of the Institute of the Aeronautical Sciences, who were among the honored guests at the National Aeronautic Meeting dinner

B—Dinner Toastmaster W. J. Blanchard with Chairman W. E. Conway of the SAE Metropolitan Section, host to the National Aeronautic Meeting

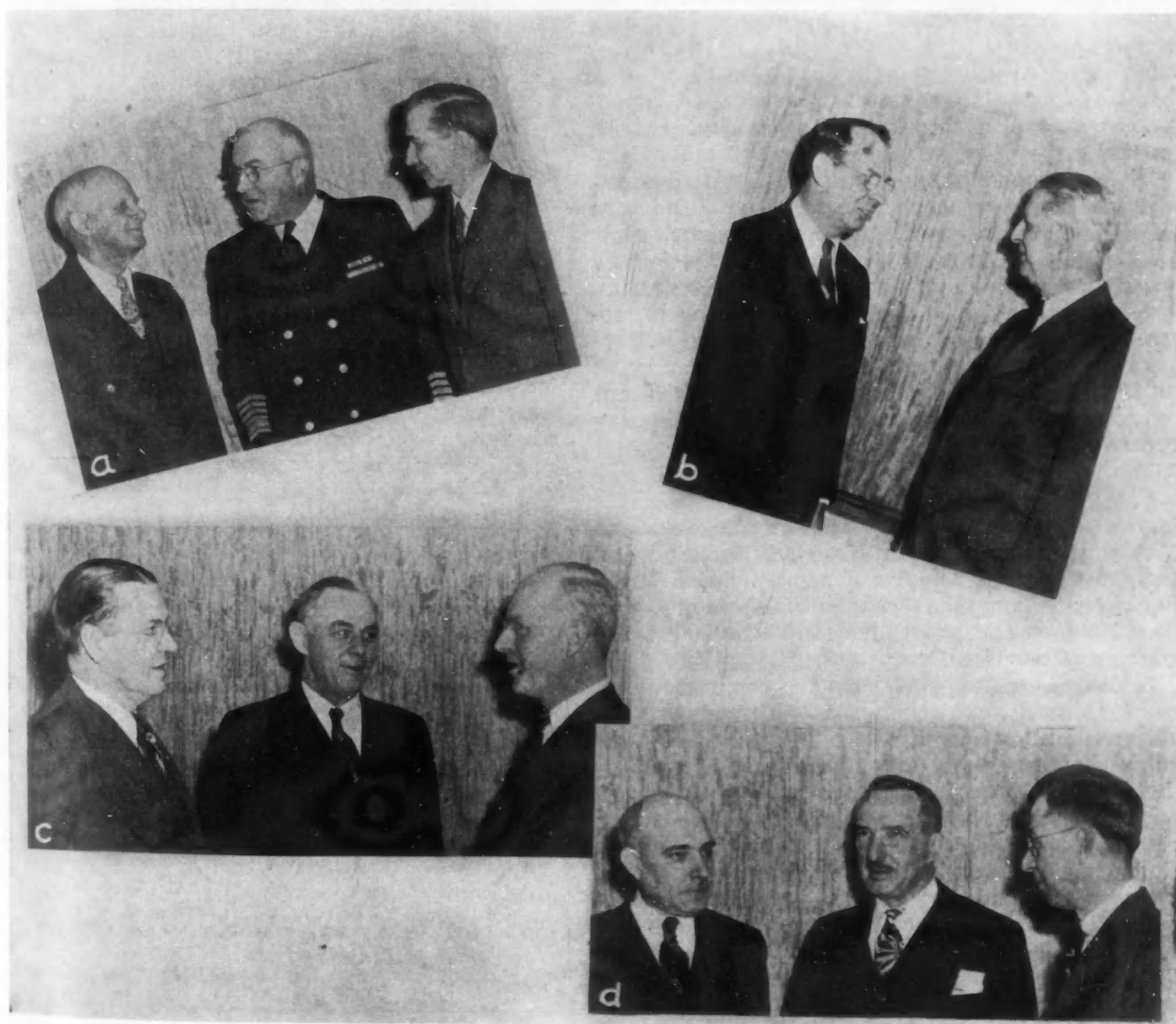
to look at the hydraulic system, we find designers of this "model" plane have solved the 1500-psi-versus-the-3000-psi hydraulic system controversy by combining the best features of each.

Closer scrutiny of the hydraulic system in our "composite" plane reveals that straight-line hydraulic motion has taken to running in circles for high-speed rotary power drives. According to a West Coast engineer, hydraulic rotary drives—featuring design compactness and reliability—loom as keen competitors of electrical units.

Outgrowth of this new effort, he reported, is the DC-6 hydraulically-driven supercharger now in production.

C—General Chairman R. W. Young of the SAE 1947 National Aeronautic Meeting (left), with Oliver P. Echols, dinner speaker, and SAE President C. E. Frudden. Retired recently as a major-general, Echols was commanding general of the AAF Materiel Command during the war, and is president of the Aircraft Industries Association of America, Inc., Washington

D—The three SAE vice-presidents responsible for the planning of the Aeronautic Meeting were Carl T. Doman (left), Harold R. Harris, and James M. Shoemaker



# POWERPLANTS

## Heading Toward Turboprops, Jets

**E**NGINEERS believe that continuing development will improve gas-turbine powerplants to the point where in 1957 they will power 45% of the commercial air transports, 88% of the bombers, 95% of the fighters, 25% of the cargo aircraft, and even a small percentage of light planes, a survey presented at one of the four Aircraft Powerplant sessions disclosed. Turboprops will be more common than turbojets except where very high speed is at a premium.

Engineers, however, are not overlooking possibilities of improving reciprocating engines—powerplants of 5000 bhp were forecast. Reciprocating engines will continue to occupy an important position during the next ten years, they expect, although reciprocating engines will constantly lose ground to gas-turbine powerplants, speakers agreed.

Prospective powerplant trends were based on a canvas of leading engineers, conducted and reported by two authors. Opinions expressed, both in the survey and at the meeting, varied widely.

After analyzing the returned questionnaires, opinion samplers prophesied that the turboprops of 1957 will have specific fuel consumptions as low as 0.45 lb per bhp-hr, thrust augmentation by means of liquid ingestion or perhaps reheating between stages of a multiple-stage turbine, regenerative cycles for units employing peak temperatures of 2200 F, and pressure ratios as great as 10 to 1. In 10 years, axial-flow compressors are expected to be almost three times as common as centrifugal compressors.

With turbojets, the trend is toward ever-increasing engine power due to military demands for higher-velocity aircraft, the authors declared. Maximum thrust outputs of 15,000 lb are anticipated for 1957. A complex design employing both liquid ingestion and afterburning might give thrust augmentation of from 100 to 200% for emergency use in military aircraft.

In discussing the development of combustors for gas turbines, one speaker related the advantages of annular chambers over can-type chambers. Annular chambers were first investigated because of their simplicity and small frontal area. Then it was found that the exit temperature distribution of this type of burner makes the best of turbine blade strength. At the root, where centrifugal loads on the blade are highest, the gas temperature is lowest. With careful manufacture, the circumferential temperature distribution is uniform. The pressure drop across the burner is remarkably low.

Based on eight papers presented at four Powerplant sessions under chairmanship of **E. G. Haven**, **Arthur Nutt**, **A. L. Beall**, and **L. T. Miller** . . . "Development of Annular Combustion Chambers," by **Stewart Way** and **E. P. Walsh**, Westinghouse Electric Corp.; "Instrumentation for the Development of Aircraft Powerplant Components Involving Fluid Flow," by **S. J. Markowski** and **E. M. Moffatt**, Pratt and Whitney Aircraft; "Helicopter Powerplant Installations," by **R. A. Wolf** and **C. P. Spiesz**, Bell Aircraft Corp.; "Future Trends in Aircraft Engine Design," by **A. T. Gregory** and **A. L. Pomeroy**, Ranger Aircraft Engines; "Detonation and Internal Coolants," by **E. F. Obert**, Northwestern University; "New Methods in Valve Cam Design," by **W. M. Dudley**, Thompson Products, Inc., and Case School of Applied Science, and **H. H. Engemann**, Thompson Products, Inc.; "Installation Engineering of Aircraft Turbo-Jet Engines," by **R. E. Small**, General Electric Co.; "What Are the Essential Requirements of a Gas Turbine Installation?" by **G. W. Newton**, Boeing Aircraft Co. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

Improved instruments for fluid-flow measurements were reported that will influence development of combustors, compressors, and turbines. Speakers emphasized that flow velocity and temperature ranges should govern the choice of a temperature probe.

The Kiel probe was called the best all-around total pressure probe because of its yaw and pitch insensitivity.

Installation problems with gas turbines were given a lot of attention. Variable-area jet nozzles for turbojet powerplants are one of the most promising installation refinements now being investigated, it was said. They give better fuel economy during cruising operation, compensate for thrust variation among engines on a multi-engine airplane, and permit operation at maximum allowable exhaust-gas temperatures at full rpm over a wide range of compressor pressure ratios or inlet temperatures, speakers said.

On the reciprocating side of the powerplant picture, the survey of future trends predicted the 1957 engine would have specific fuel consumptions as low as 0.33 lb per bhp-hr for the compound engine, increased compression ratios, fuel injection

Highlights of the SAE National Transportation Meeting, April 16 to 18, at Chicago, will be reported for the June issue of the SAE Journal by on-the-spot reporters.

Twelve technical papers will be presented at that three-day meeting, which is being sponsored by the SAE Transportation & Maintenance and the Truck & Bus Engineering Activities of the Society, with the cooperation of the SAE Chicago Section.

Our printing schedule makes it impossible to report this joint meeting in this issue.

in place of carburetion, bmep's as high as 310 psi, and higher piston speeds. There is a swing toward more compounding of reciprocating engines with exhaust-gas turbines.

In discussing detonation and internal coolants, another speaker said that detonation is a process usually present in varying degrees, not one which appears at a critical compression ratio. He defined detonation as the existence of a measurable pressure differential within the chamber. Reduction in detonation is characterized by a decrease in coolant load and an increase in exhaust-gas temperature.

It was explained that the injected water suppresses detonation by slowing down combustion and by cooling the end portion through vaporization of water in the charge there. Water, with its high latent heat, is an especially good coolant, but it must be finely atomized and given time to vaporize.

Flexibility in the linkage between valve and cam was termed the chief cause of bad valve motion. This fact was uncovered when actual valve motion was superposed on theoretical valve motion. A two-part mathematical method was proposed for bringing the actual motion closer to the desired motion. First, the desired valve motion is specified for the design speed. Then, this information, together with data on the linkage characteristics, is used to calculate the cam profile which will impart the desired valve motion. The calculations can be made easily on punch-card machines used for accounting purposes.

"Whittlin' " and imagination are the core of the art of designing helicopter installations, according to a man who ought to know. He told how blade



Frederick V. H. Judd, United Aircraft Corp. (left), being congratulated for winning the 1946 SAE Wright Brothers Medal by G. A. Page, Jr., chairman of the Award Board. Judd's winning paper was "A Systematic Approach to the Aerodynamic Design of Radial Engine Installation"

solidarity is chosen so that the rotor's hovering requirements and stall characteristics are matched to the engine's power outputs at various altitudes.

A helicopter must have provision for engine cooling during hovering near the ground and at altitude as well as during forward flight. Rigid pylons are used with rotors having an odd number of blades.

The odd blades balance out certain parts of the periodic forces which act on the mast during forward flight. Two-bladed rotors are simpler in construction and make storage easier but require elastic suspension of rotor, transmission, and engine.

## Safety, Reliability Cited as Goals of AIR TRANSPORT

Based on six papers presented at three Air Transport sessions, under chairmanship of R. C. Loomis, H. R. Harris, and J. G. Borger . . . "Automations for Tomorrow's Aircraft," by Hugo Schuck and Gordon Volkenant, Minneapolis-Honeywell Regulator Co.; "Electrical Power and the Transport Airplane," by E. P. Buckthal, United Air Lines, Inc.; "Passenger Seats Can Be Comfortable," by C. W. Morris, Doak Aircraft Co., Inc.; "Integrated Landing Aids," by R. D. Kelly and R. L. Champion, United Air Lines, Inc.; "The Effect of Civil Air Regulation Performance Requirements on Airplane Design," by John E. Steiner, Boeing Aircraft Co.; and "Suggested Design and Operating Requirements for Cargo Transports," by J. E. Winchester, Slick Airways, Inc. . . . All of these papers will appear in briefed form in forthcoming issues of the SAE Journal, and those approved by Readers Committees will be published in full in SAE Quarterly Transactions.

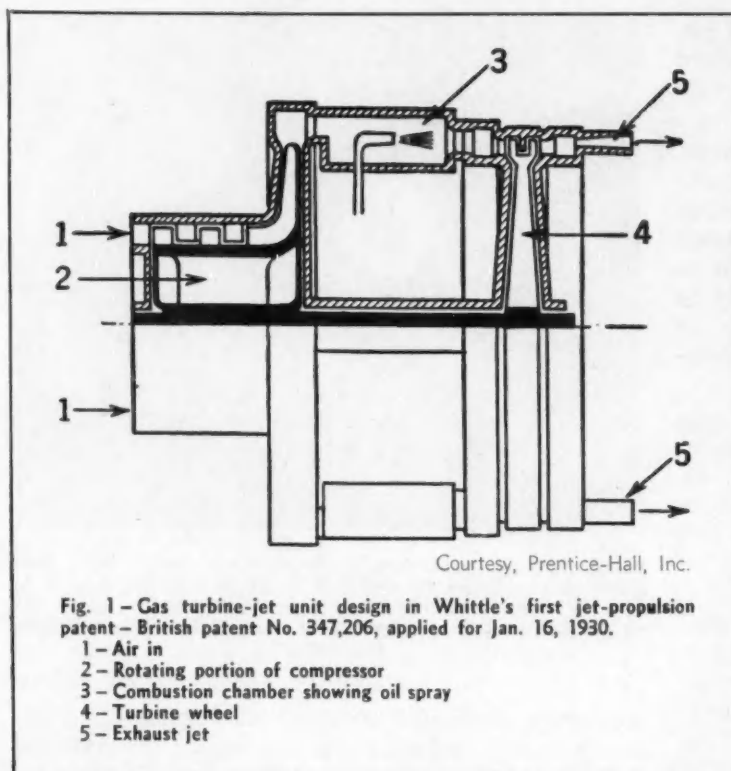
**A**IRLINE operators are now in the midst of a vast program to replace their warworn planes. The three Air Transport sessions revealed that the new planes will have greater safety, reliability, and

comfort, increased performance, and ability to operate almost independently of weather conditions.

Both safety and reliability are being advanced as the result of a study of landing aids for all-weather operations, which appears to settle the controversy of GCA (ground controlled approach) versus ILS (instrument landing system) by calling it a draw. It was stated definitely that no one aid by itself can achieve the necessary safety and reliability.

Solution appears to be to use ILS as the basic electronic aid for routine operations, with some form of radar, such as GCA, to act as a monitoring

Continued on page 101



# Review of J

**T**HE modern gas turbine got its start toward general use about 1930 when Frank Whittle applied for his first jet-propulsion patent. Fig. 1 shows that he had in mind a combination axial-flow and centrifugal air compressor, a combustion chamber, turbine, and jet nozzle. This type of compressor was apparently abandoned in favor of the double-entry centrifugal compressor. The original unit designed by Whittle had a large, snail-type combustion chamber. (See Fig. 2.) It first ran in 1937 for 3½ hr, and successfully demonstrated the possibility of the jet-propulsion engine.

The next engine designed by Whittle had the large and clumsy snail-type single combustion chamber replaced by a number of smaller chambers, resulting in a more compact design, as shown in Fig. 3. The fuel burner was of the vaporizing type, the main turbine bearing water cooled.

Fig. 4 shows the type of design that was used in the first flight engine. Ten hours were flown in May, 1941. The jet engine was now well established as an aircraft powerplant, and several British companies were assigned the task of producing gas turbine units. This opened the way for expansion in detail design.

## British Designs

Several De Havilland-Halford Goblin jet engines were used in our planes during the war. This engine has only a single-entry centrifugal compres-

sor. Where the Rolls-Royce Nene has a reverse-flow combustion chamber, the De Havilland has a straight-through flow type of combustion chamber. Rolls-Royce engineers, however, were aware of the advantages of the straight-through flow type, for they used it in their Derwent engine. A small, centrifugal fan was added to this engine to help in the cooling. The double-entry centrifugal compressor was retained and the reverse-flow combustion chamber was replaced with a through-flow chamber.

We now come to the British Metropolitan-Vickers F-2 and the Armstrong Siddeley A.S.X. units. They are axial-flow compressor engines instead of centrifugal compressor units, in direct opposition to Whittle's ideas. On his last visit here he was quite emphatic in his feeling that the centrifugal compressor was superior to the axial-flow compressor. There are, however, just as emphatic feelings toward the axial-flow compressor by many American designers.

Fig. 5 shows a cross-section of the Armstrong Siddeley A.S.X. In this engine the air enters radially and flows forward through the axial-flow compressor, then to the combustion chambers and the turbine wheel.

The Metropolitan Vickers F-2 uses a combustion chamber of the annular type, rather than a large number of individual can-type chambers. A drum is used in the compressor instead of individual discs. This has been a moot question among designers. The drum construction is certainly lighter

\* "Design Development of the Gas Turbine" was presented at SAE Buffalo Section, Nov. 15, 1946.

# JET DESIGNS . . .

## 1930 to 1946

EXCERPTS FROM A PAPER\* BY

**Clifford J. Lane**

Chief, Design Division, Fredric Flader, Inc.

and has many other advantages. A hollow, cone-type shaft is used in combination with the compressor drum, the whole being mounted on two bearings and carrying the main turbine disc. This construction provides an economical design from the weight standpoint.

There is one more British development that I would like to mention, although we do not know much about its construction as yet. The Bristol Theseus gas turbine is of the propjet type, that is, it drives a dual propeller by means of independently mounted turbine wheels and also utilizes a regenerator for utmost economy. This is the first instance of the use of a regenerator in an aircraft powerplant.

### German Designs

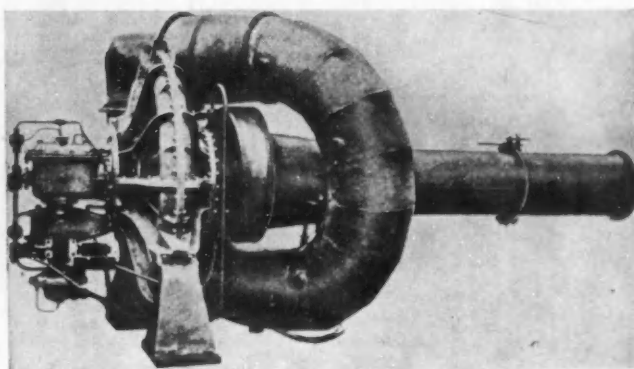
So far, we have considered only British designs, but the Germans were active, too. In fact they were conducting tests at the same time as the British and brought out several interesting designs.

One of the first units to be brought to this country for analysis and test was the Jumo 004 turbojet engine. This design employed an 8-stage axial-flow compressor, six individual can-type combustion chambers, a single-stage turbine, and a tail cone with an adjustable bullet.

This unit, while on test, forcibly demonstrated the power of the compressor used. Capt. W. C. Gerler of Wright Field was testing this unit one day and noticed an oil leak that appeared to be in

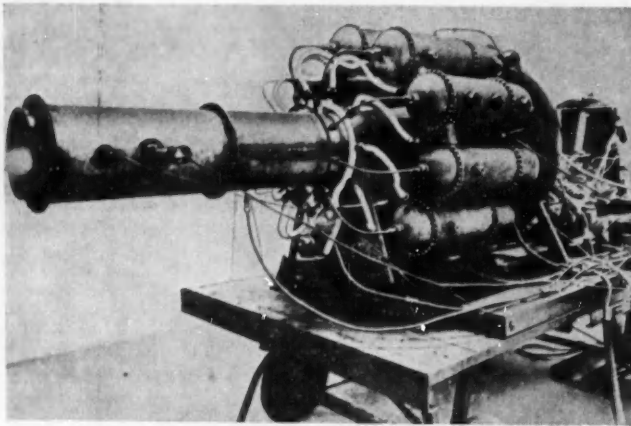
the accessory section. A mechanic volunteered to tighten the connection without shutting down the test. As he reached over to make the adjustment he was suddenly sucked into the air intake and promptly lost his shirt. The engine had to be shut down before he could be released. Examination of the engine failed to show any part of his shirt, fountain pen, or pencil. They had simply disappeared. There was no apparent damage to anything except the mechanic.

The German BMW 003 differs from the 004 in the detail design of the axial-flow compressor, having seven stages instead of eight, and an entirely different disc design. It also differs in the combustion-chamber design, as it employs a simple annular type of chamber with 16 burners instead



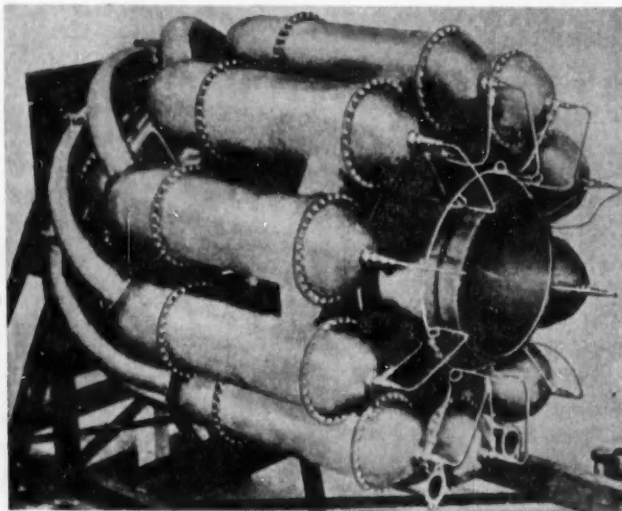
Courtesy, General Electric Co. and AAF, Matériel Command

Fig. 2 - Original unit designed by Whittle



Courtesy, General Electric Co. and AAF, Matériel Command

Fig. 3 - Second Whittle gas turbine



Courtesy, General Electric Co. and AAF, Matériel Command

Fig. 4 - Power Jets Whittle gas turbine

of the six individual combustion chambers on the 004. The turbine is also a single-stage unit with the disc bolted to the shaft. The 003, however,

employs bolts going through the disc, while the 004 actually uses capscrews that do not go through the disc. The 003 also uses an adjustable tail cone bullet to adjust the nozzle opening.

### Swiss Designs

Before leaving the foreign development of gas turbines, there are two outstanding Swiss units that we should consider briefly. Brown, Boveri and Co., one of the early developers of the axial-flow compressor, has built many types of gas turbines. They are used all over the world, especially by oil refiners using the Houdry cracking process. The Socony-Vacuum Oil Co. has a unit employing an axial-flow compressor. This unit was recently disassembled for inspection and overhaul after more than six years of continuous service. It was found to be in excellent condition, indicating the life expectancy that may be anticipated with this type of machine.

The second Swiss unit is the Escher Wyss AK closed-cycle turbine. This type of turbine offers many advantages and opportunities for obtaining high thermal efficiency, the efficiency being on the order of 40%, thus competing with the best diesel practice. This is an entirely different design from those we have discussed previously.

Fig. 6 shows diagrammatically the comparison between the open cycle and the closed cycle. In the open cycle the air is taken in by the compressor, brought up to pressure, heated in the combustion chamber, expanded in the turbine, and exhausted to the atmosphere. If a heat exchanger is used, it adds to the thermal efficiency by transferring heat from the exhaust gas to the unheated air, thus reducing the quantity of fuel required for a given power output. Looking at the closed cycle, we find that the air or gas that is the working medium is entirely closed in the circuit and simply goes round and round, being compressed, heated, expanded, and recompressed.

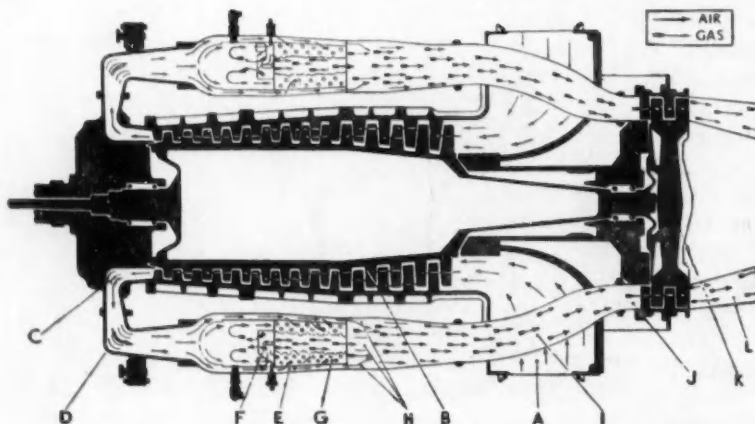


Fig. 5 - Armstrong Siddeley reverse-flow axial compressor turbojet

Intake air enters at ports A between 11 combustion chambers, then through 14-stage axial-flow compressor B, final stage raising pressure to about five atmospheres; air, which is then displaced outwardly by radial guide vanes C, is divided into 11 parts and is directed into elbows D, which incorporate guide vanes and lead into combustion chambers E; approximately 25% of air goes to inner chamber fitted with mixing chamber F, where paraffin fuel is injected; remainder of air enters chambers through perforations G in rear half of inner chamber and in directional scoops H; burning gases then flow into manifold I and are reformed at annulus J at entry to 2-stage turbine K before going through exhaust nozzle L; front main bearing, in addition to supporting main shaft carrying compressor and turbine, also takes thrust and is relieved of major part of load by cup, or equalizer piston, on front end of shaft into which air from high-pressure end of compressor can pass.

Fig. 7 shows the actual cycle of one of the Escher Wyss units. It consists of four compressors, four intercoolers, two turbines, and two heaters or hot gas boilers, and a regenerator. The lowest pressure in the system is 80 psi absolute, a pressure that many open-cycle units attain as a maximum, and reaches a maximum of 900 psi absolute before entering the regenerator, a compression ratio of 11.2-1. Such a unit as is indicated in this cycle diagram is, of course, intended for stationary plant operation, as the size of the units involved is too great for either airplane or marine use. For stationary powerplants, however, it gives promise of providing considerable competition for the now existing steam powerplants from the standpoint of thermal efficiency, size, and, with refinement, financial investment. This type of cycle also makes it possible to use coal as a fuel, since the difficulties with the abrasive action of fly ash are eliminated.

#### American Designs

There are a large number of American companies active in the gas turbine field. To name a few, we have the General Electric Co. developing both centrifugal and axial-flow compressor units, such as the I-16, I-40, both centrifugal, and the TG-180 and TG-100, both axial-flow machines. Westinghouse has the 9.5 and 19-A and B machines, which are axial flow with annular combustion chambers. Allis-Chalmers has a large axial-flow compressor and multi-stage turbine machine; the Elliott Co. has a positive blower unit of the Lysholm type and a multistage turbine for marine use; and others, including Fredric Flader, Inc., which have an axial-flow compressor and multi-stage turbine considered by the AAF as the most advanced design in the U. S. This turbine employs a planetary reduction gear for counterrotating propellers, axial-flow compressor, can type combustion chambers, multistage turbine, and tail pipe with adjustable bullet to vary the exhaust nozzle area.

The General Electric Co. was the first producer in this country of a jet-propulsion unit. The I-16 was a direct copy of the Whittle unit brought over from England. The next G.E. unit, the I-40, was larger and more refined in design. It follows the British design closely, using a double-entry centrifugal compressor with through-flow combustion chambers and single-stage turbine. The axial units TG-180 (turbojet) and TG-100 (propjet) are, however, distinctly American in design. Both are axial-flow compressor units with individual combustion chambers and single-stage turbines. They do not employ a regenerator.

Westinghouse has attacked the problem a little differently with good success. The Westinghouse unit is of the axial-flow compressor type, employing an annular combustion chamber and a single-stage turbine. The inlet air first passes through

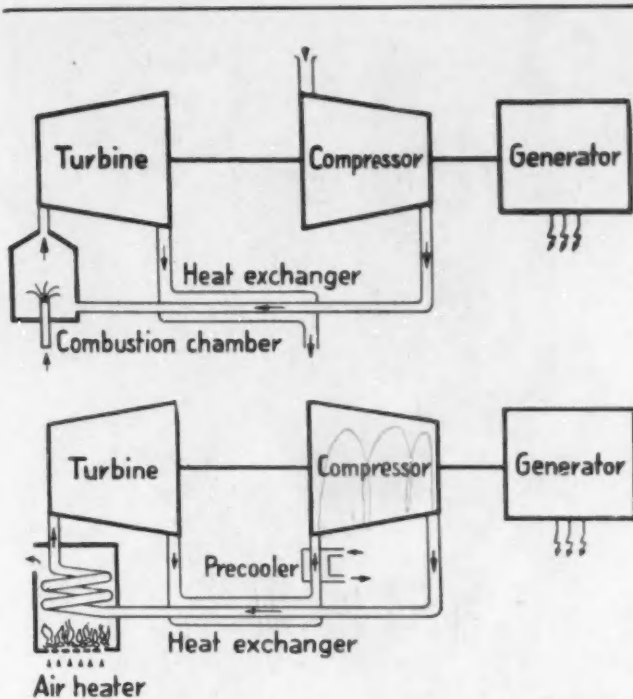


Fig. 6 - Comparison of open (upper view) and closed (lower view) cycles

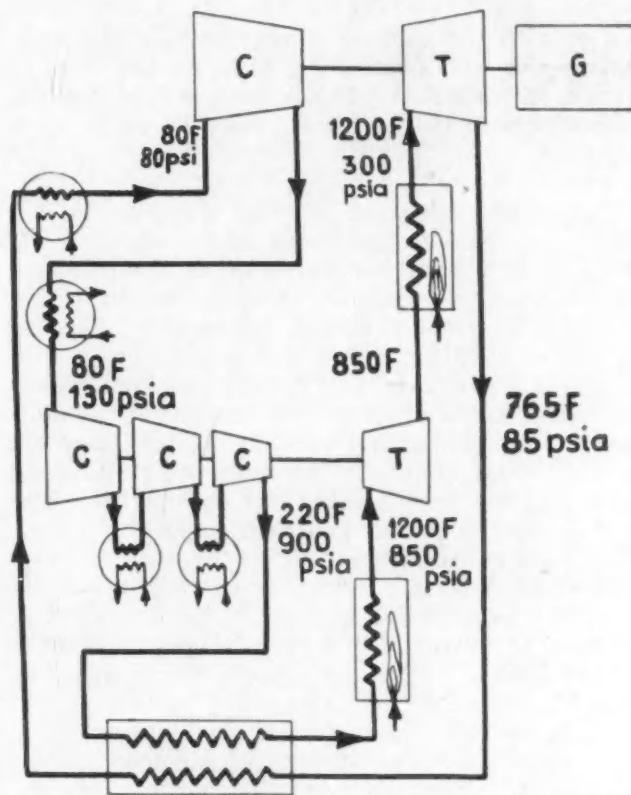


Fig. 7 - Escher-Wyss closed cycle

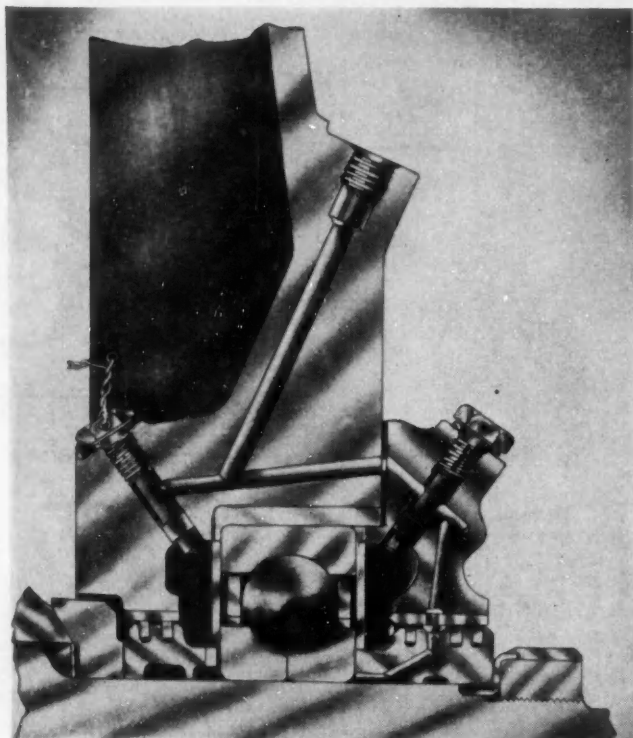


Fig. 8 - Typical radial thrust ball bearing mounting

the oil cooler, then it is compressed by the 6-stage axial-flow compressor. Fuel is added and burned in the annular combustion chamber, delivering the hot gas to the turbine wheel through the usual nozzle ring and exhausting through the exhaust nozzle, which has an adjustable cone. This turbine also differs in the high-speed bearing setup, as it employs plain sleeve bearings instead of ball bearings.

The Elliott-Lysholm 2500-hp gas turbine for ship propulsion is unique in many respects. It employs two positive-type Lysholm compressors, two multistage turbines, two combustion chambers, an intercooler, and a regenerator. For an output of 2500 hp, it is quite large compared to an aircraft gas turbine. The Lysholm compressor is a rather peculiar design, reminiscent of the well-known rootsblower but actually compressing air in a different manner. The male rotor has four lobes and the female rotor has six cavities. The profiles are, of course, generated, and give an interesting compressive action on the air.

Our last American design is the machine built by Allis-Chalmers for marine applications. It is designed to deliver 3500 hp and to operate eventually at 1500 F. It is very large, occupying considerable space.

Again we have a different combination of a single compressor axial-flow type delivering its air through a regenerator and to two combustion chambers, one supplying a turbine that drives the compressor and the other the power output turbine, both exhausting to the stack through the

regenerator. This unit is still on test, the test program being an extensive one to determine the behavior of the various parts as the temperature is gradually increased, eventually reaching a maximum of 1500 F. This is a low pressure rise per stage design, requiring a large number of stages.

We will now consider some of the detail points of design of the individual gas turbine units. If the particular design we are considering is a prop-jet or some type of marine or industrial application, it will require a reduction gear. Gas turbines operate at much higher speeds than conventional engines do, so greater reductions are required. Aircraft units turn up from 6000 to 30,000 rpm. The reduction gear can be either of the back gear type, spiral or worm drive, or the planetary design. Where compactness and weight are important, the planetary design is preferable. The spiral or worm gear drive is able to give high-speed reduction but, due to the poor efficiency, is seldom used. The back gear design is satisfactory for some applications as it can be made efficient, but it is on the bulky and heavy side. Such factors as pitchline velocities, tooth contact areas, and tooth loading must be given careful attention. With these high-speed applications, pitchline velocities especially must be carefully considered. The gas turbine is capable of producing large horsepower in a small space—on the order of 6000 to 10,000 hp for certain applications—and such powers transmitted through gear reductions of minimum size and weight require that the designer really sit up and take notice. One application has a power-to-weight ratio of 12 hp per lb. For other than aircraft applications it is permissible to reduce this ratio, depending on the application.

The subject of compressors is open to a lot of debate. In this country G.E. has been the greatest proponent of centrifugal compressors, based on their extensive experience with centrifugal superchargers. Westinghouse and Allis-Chalmers favor the axial-flow compressor. At a conference attended by the foremost engineering talent in the country about a year ago, the author was amazed to hear a hot discussion on the relative merits of these two types, based on whether it was preferable for the air to make its way through the centrifugal compressor in a rather straight line radial direction or to make its way through the various stages of an axial-flow compressor in a helical manner, eventually catching up with itself when it emerged at the high-pressure end.

Actually, there are two important considerations: cost and efficiency. If cost is paramount then the centrifugal may be the answer. If, however, efficiency is paramount, then the axial-flow compressor should be chosen. We have been able to attain a maximum efficiency of only 80-82% with the centrifugal, while 87-92% can be obtained with the axial. Under certain conditions, the NACA has obtained as high as 97% efficiency.

Compressor rotors are generally mounted on ball or roller bearings, although plain sleeve-type bearings have been used with success, as in the case of the Westinghouse 19-B. Lubrication is by means of oil mist or solid jet in the case of the antifriction type of bearing. The solid jet type of lubrication is gradually supplanting the oil mist, due to better heat removal from the bearing. An example of this design is shown in Fig. 8. The bearing used is a special ball-type with split inner race. It carries 7600 lb thrust load at 6000 rpm. Oil is forced under pressure through the jets and impinges on the bearing retainer, being thrown outwardly by centrifugal action, and draining away through large drain holes in the case. Bearing temperature can be kept below the maximum allowable of 250 F without difficulty and, of course, afford ample lubrication. Tests show that with proper drainage there is no oil built up in the bearing itself with its consequent churning and heating.

Centrifugal compressor rotors are generally machined from the solid. Axial rotors are made up in a number of designs. For the high peripheral velocities it is necessary to use carefully designed discs due to the high stresses involved. An interesting comparison can be made between present-day aircraft practice and commercial flywheels. Flywheels used with commercial compressors of the positive-flow type built by Worthington operate at peripheral velocities of less than 100 fps. In aircraft we use 100-1400 fps. Since centrifugal force goes up as the square of the peripheral velocity, an idea of the magnitude of the forces involved is indicated.

### Blades

Blades are fastened to the discs in a variety of ways. Each method has its own advantages and disadvantages, and they must be evaluated by the designer before adoption. In the bulb type, the blade must be carefully fitted and prevented from axial movement by staking. The Christmas or fir tree type requires accurate machining and fitting. In the attachment on the BMW 003 turbine wheel, the blade is hollow and attached by means of a type of bulb fitting with wedge pins welded in place. Another type in use is bolted and threaded. The latter is the only type that will permit adjustment of blade angle for maximum efficiency. The rotor assembly consists of the discs and blades and, if the design specifies it, the drum. The German 004 unit did not use the drum but depended on shrouding the stator vanes to fill the gap between the discs. The G.E. TG-180, on the other hand, fills the gap with a ring, giving in effect a solid drum and eliminating the shroud on the stator blades. Again this is pretty much a matter of designer's choice. Materials used are varied, depending on the application. Blades are

precision cast, forged, or machined from the solid. The material generally used is steel with a high tensile strength and a high degree of damping capacity. As we design for the highest efficiency, laminar flow airfoil sections are used and, due to the thinness of the section, high strength and vibratory damping capacity are required. The stresses involved may be on the order of 45,000 psi for a load of 7200 lb at rated speed. Blade sections at the root will be on the order of 0.150 in. thick. Blade attachment stresses may be on the order of 90,000 psi.

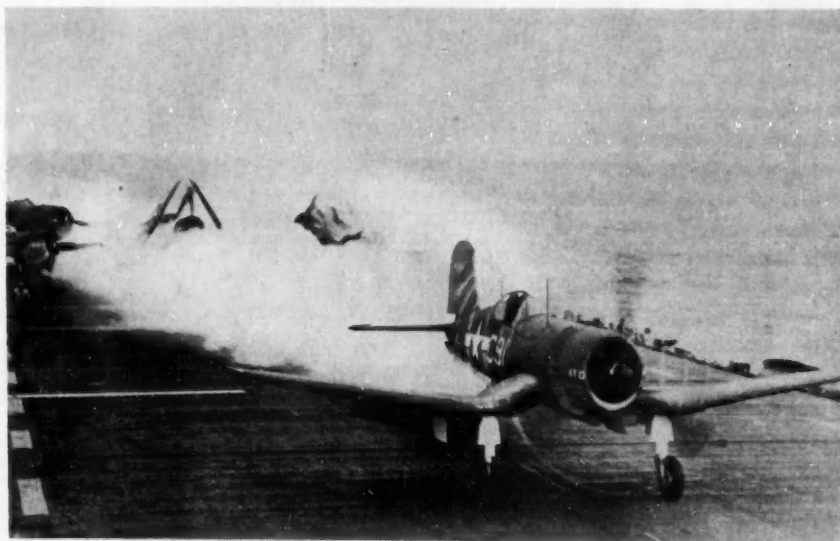
### Combustion Chambers

The combustion chamber must be designed so as to stand up under the high pressures and temperatures involved and yet be readily serviced to replace parts that inevitably burn out. Air pressures are on the order of 75 to 600 psi, temperature of the entering air 400 F and higher, combustion 3000 F and higher, and at the turbine inlet nozzle 1600 F and higher. Air velocities on the order of 400 fps and heat release rates of 5,000,000 to 10,000,000 Btu per cu ft are required. The individual bottle or can type of chamber is used most often as it permits easier replacement and the confinement of pressure and temperature in small areas is easier to handle. The annular chamber is being used with success. It has the advantage of fewer parts and smaller overall diameter.

The power turbine is the most difficult part of the machine from the standpoint of mechanical design. Here we have the combination of everything that is difficult: high rotative speeds and high temperatures. Gas velocities are high—and this with high temperature and stress means short life for certain parts.

A typical turbine blade illustrates the problem that the metallurgist and the designer have to solve. The working temperature of the blade is 1350 F, whereas the as-cast or as-forged temperature is 1950 F. This doesn't seem to be much of a difference, yet we must make this blade to withstand a load of 4500 lb and a stress of 25,000 psi with an absolute minimum of creep. As a rule, the high cobalt alloys, such as vitallium or modifications thereof, are employed. They must have high stress rupture properties and low creep rates at the desired working temperatures. As a result they are so hard that ordinary machining is impossible and grinding only can be used. The forging or casting process, therefore, must produce blades to almost unheard-of accuracy in order that a minimum of grinding may be required. A great deal of credit is due to the metallurgist for the work he has done to make this possible today. Without his patient effort in combining elements to give us such blade materials, we could not have the gas turbine. The idea of the gas turbine is old, but the metallurgist has made it modern.

# Naval Air Power—Its Past, Present,



**N**AVAL aviation is first and last a form of sea power. As long as there are ships that cruise on and under the sea, our own ships must move freely in wartime, and enemy shipping must be suppressed. Regardless of how much faith we have in the future of aviation, and barring unknown inventions of the future, it seems that the economic factor alone will keep the airplane from supplanting surface shipping.

The airplane may compete with the ship in overseas transportation, but it is significant that through a hundred years of competition with its highly-developed rail system, England has always used ships to move a large percentage of tonnage from point to point within its own single island. We all hope that firm and permanent international agreements will eventually eliminate the possibility of war, but until that time comes, the existence of commercial shipping is the reason for sea power and the Navy, and for a part of naval aviation.

It seems obvious that as long as there are ships, and as long as they can be used to do things in war which cannot be done as well, if at all, in other ways, they should be developed and employed to that end. That is the continuing reason for the airplane carrier and the rest of naval aviation.

For some time to come, it is clear that the landplane is the most effective weapon for naval reconnaissance and anti-submarine warfare, and, therefore, should be so employed and developed further. The flying boat remains in the major military pic-

ture because of its irreplaceable value during the critical period when an assault is in progress before fields large enough for even specially-designed long-range landplanes can be had. The flying boat was invaluable for such service in the Solomons, the Marianas, the Ryukyus, and generally throughout the Pacific campaigns.

As far as the more distant future is concerned, the answer to the question of seaplane versus landplane is not so clear.

## Seaplanes versus Landplanes

There are many factors which may favor the seaplane. Many papers have been written in the past arguing that the seaplane has an advantage with increased size; researches in high length-beam ratios, step configurations, and afterbody lines, already show important performance gains; the possible disappearance of propellers would eliminate a disadvantage, and perhaps the base logistics of the landplane will some day overwhelm it.

The Navy does not know the answer, but it intends to find out if there is one.

Although the Navy continues to find shipboard seaplanes useful, it does not appear that they have an expanding future, at least in their present form. All complex instruments of war are brought about by a working out of compromises between a multitude of conflicting desires. The warship is no exception. Ship-borne seaplanes impose upon space and weight for placement, stowage and handling, both for itself and catapult, and for its crane handling and recovery equipment.

\*Paper "The Development of Naval Aircraft," presented at SAE National Aeronautic Meeting (Spring), New York City, on April 10, 1947

# t, and Future

EXCERPTS FROM A PAPER\* BY

## Rear-Adm. L. C. Stevens

Assistant Chief of Research and Development, Navy Bureau of Aeronautics

These compromises were accepted in ship design, but to do a proper job, aircraft have long since outgrown their longer-lived ships. You all know the steady upward curve of airplane gross weight with increasing performance and more versatile equipment. The economics and further compromises involved in continually and progressively adjusting an entire Navy to this curve are so great as to rule it out.

There is one other aspect of non-carrier ship-board aviation which should be mentioned. That is the helicopter. When the submarine menace was at its height during the last war, the Navy was freely criticized because it was not in favor of seizing on the helicopter and utilizing it on board all sorts of ships as an immediate means of defeating the submarine. The perspective of time has justified the Navy's position in this matter.

As far as aircraft are concerned, the submarine was adequately handled by conventional aircraft, including the hunter-killer groups operating from small carriers which were underway but not yet in service at the time of the helicopter controversy. The helicopter was not then, and is not yet sufficiently developed for the job.

In its carrier landplanes, naval aviation went through some early days when powerplants were not as reliable as now and forced landings at sea could more or less be expected. Even so, it was obvious that regardless of reliability of engines, combat would never free us from that contingency.

The development of the wide range of separate rescue equipment made it possible to free the airplane structure from flotation requirements, substituting equipment which rapidly grew more effective in proportion to its weight.

The general history of carrier aircraft is that of the shore based counterparts— heavier guns, more ammunition, heavier engines, more fuel, greater performance, and more equipment— par-

ticularly the wizard electronic aids. We were still only experimenting with self-sealing tanks and armor, when on May 11, 1940, the day that the Germans entered the Low Countries and the war passed from the "phony" stage to one of extreme urgency and gravity, we were forced to permanently add those heavy increments to the total weights of all existing and future combat aircraft. This step almost, but not quite, finished the catapult seaplane, with its rigid upper limit on gross weight.

Our carrier landplanes had no such rigid limits and absorbed the increases with sufficient reserve to permit them to fight the Japanese with approximately equal performance and greatly superior toughness. The results are history—as high as 15 Japanese aircraft shot down for every one of ours.

An interesting result of quantity operation of an air force is the rise of new types of aircraft—the night fighter, and several other varieties that the capabilities and limitations of electronics and armament brought into being. Where possible, they are obtained by modifications of existing models of aircraft basically suitable for carrier use because designed for that purpose. There is no doubt but that new combinations and specially designed types will continue to arise. With a real sea-borne air force, we can divert a few planes from single carriers, or even divert a carrier or two to serve a common purpose. With carriers acting singly, this cannot well be done.

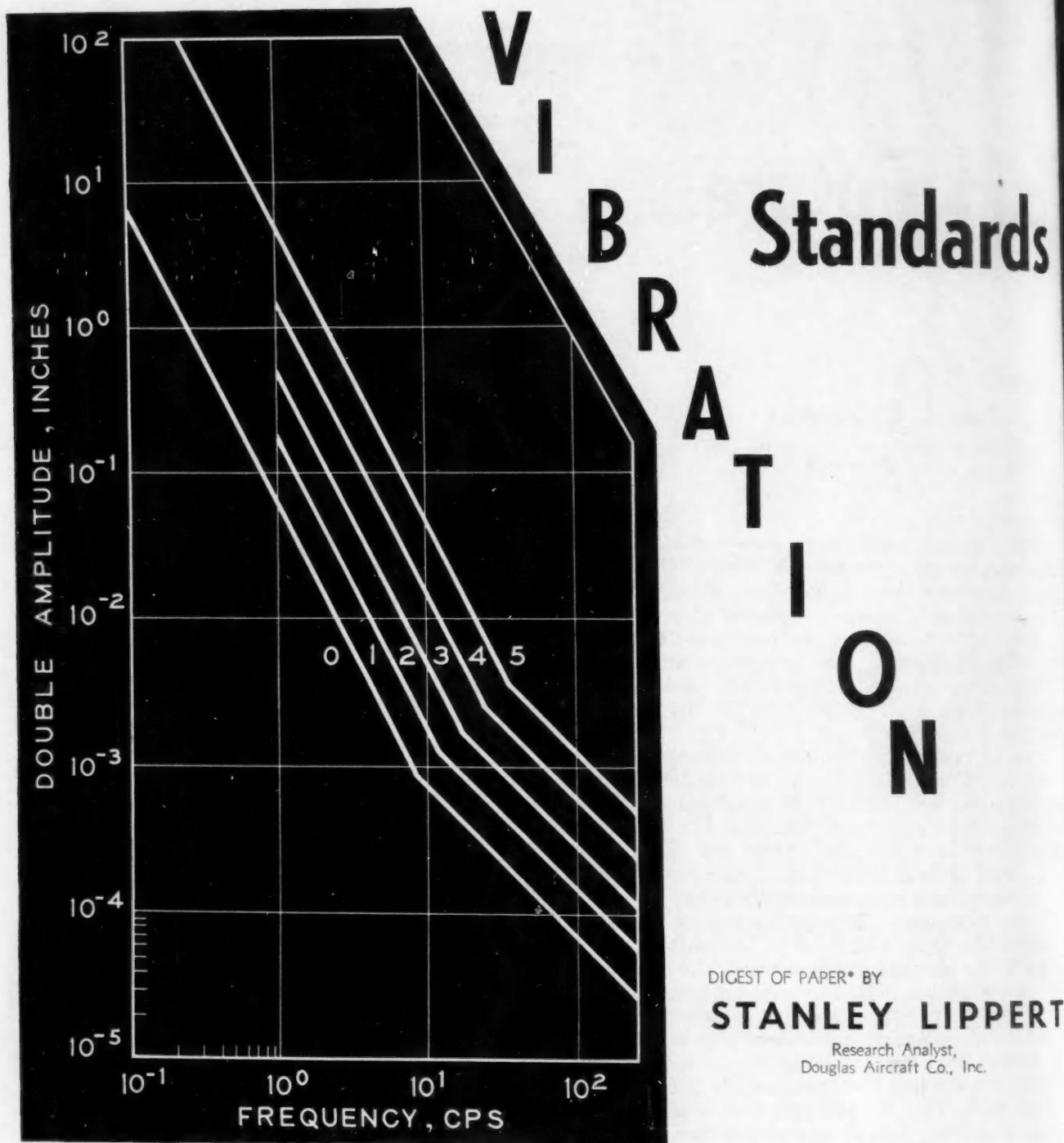
### Must Satisfy Special Needs

Design compromises which must be made in carrier-based aircraft are quite different from those that should be made in shore-based aircraft. Arresting gear and catapulting provisions must be added; strength and ruggedness provided for different conditions; take-off compromises must be made to permit operation of maximum numbers; folding wings or other special arrangements must be used to develop carrier capacity to a maximum; limiting elevator, flight deck, and hangar clearances must be met; crash barrier safety must be provided; special vision must be provided for landing; and even the handling, stability, and control provisions are special for the landing and wave-off conditions.

It is significant that the difference of only 2 or 3 in. in dimensions made it necessary to build complete new wings for the Corsairs that were operated from British carriers.

Twenty-five years ago a standard carrier fighter weighed about 2000 lb. In the next 10 years its weight doubled. By the beginning of the war, it was up to 12,000 lb, and since then several designs have exceeded 20,000 lb. Other types are subject to the same upward trend, and, although our carriers are flexible, they are not made of rubber; the

concluded on page 34



DIGEST OF PAPER\* BY

**STANLEY LIPPERT**

Research Analyst,  
Douglas Aircraft Co., Inc.

**Fig. 1. Proposed standard regions of human response to vertical vibrations of aircraft**

- 0 Imperceptible – not noticeable**
- 1 Barely perceptible – just noticeable**
- 2 Distinctly perceptible – well noticeable, distinctly noticeable, (not uncomfortable)**
- 3 Slightly disagreeable – strongly perceptible, disturbing, not pleasant**
- 4 Disagreeable – unpleasant, annoying**
- 5 Exceedingly disagreeable – very uncomfortable, painful, unbearable**

\* "Human Response to Vertical Vibration," was presented at SAE National Aeronautic Meeting (Fall), Oct. 5, 1946, Los Angeles.

# Proposed

**A**LTHOUGH vibrations transmitted through airplane structures to the body of the passenger are complex, there is a continuity to the thresholds of feeling and of discomfort throughout a range of amplitudes and frequencies which adequately covers the interests of the aircraft industry.

This conclusion can be expressed graphically in a family of curves (Fig. 1) – based on interpretation of previous researches – which embraces the full range of aircraft oscillations and vibrations. Six categories of classification are used, and the curves are proposed as standards for the aircraft industry. Synonymous words are used to describe a particular response. The comfort regions are:

- 0 Imperceptible, not noticeable
- 1 Barely perceptible, just noticeable
- 2 Distinctly perceptible, well noticeable, distinctly noticeable (not uncomfortable)
- 3 Slightly disagreeable, strongly perceptible, disturbing, not pleasant
- 4 Disagreeable, unpleasant, annoying
- 5 Exceedingly disagreeable, very uncomfortable, painful, unbearable

(For convenience, only one descriptive term is used on the graph.)

Because variations exist in responses of individuals, perhaps between sexes, and the same individual tested on successive days, the general shape of each curve is more important than its precise mathematical description.

Each of the investigations studied as a basis for this proposed aircraft classification covered a limited range of frequencies within the scope of its respective studies. Most of them were based on subjective classification of the degree of discomfort experienced without regard to the physiological source. (Headache and nausea, for example, are both "disagreeable," but their basic causes are probably different and due to different exciting frequencies and amplitudes.)

From systematic comparison of the previously developed comfort curves, however, was derived the

Mr. Lippert has reconciled graphically the findings of a number of studies on the effects of vertical vibration – and come up with "an easy classification of human responses to a vertical sinusoidal motion". This classification he proposes as a standard for the aircraft industry.

The investigators upon whose work Lippert has based his conclusions include:

Engineering Bulletin, Purdue University, Vol. XVII, No. 3, May 1933, "Riding Comfort Analysis," by H. M. Jacklin and G. J. Liddell.

SAE Journal, Vol. 39, Oct. 1936, pp. 401-407: "Human Reactions to Vibration," by H. M. Jacklin.

SAE Journal, Vol. 31, Nov. 1932, pp. 445-456: "Vibration of Instrument-Boards and Airplane Structures," by S. J. Zand.

SAE Journal, Vol. 53, Nov. 1945, pp. 648-659: "Propeller Balancing Problems," by S. G. Best.

The Journal of the Royal Aeronautical Society, March 1932, pp. 205-207: "Aircraft Vibration," by H. Constant.

Forschung auf dem Gebiete des Ingenieurwesens, Vol. 2, Nov. 1931, pp. 381-386: "Die Empfindlichkeit des Menschen Gegen Erschütterungen," by H. Reiher and F. J. Meister.

Engineering, Vol. 157, Jan. 28, 1944, pp. 61-63: "Human Susceptibility to Vibration," by F. Postlethwaite.

Journal of Psychology, Vol. 20, July 1945, pp. 3-8: "The Effects of Various Accelerations Upon Sickness Rates," by S. J. Alexander, M. Cotzin, C. J. Hill, Jr., E. A. Ricciuti, and G. R. Wendt.

Journal of General Psychology, Vol. 22, 1940, pp. 281-289: "The Perception of Mechanical Vibration, Part III, The Frequency Function," by F. A. Geldard.

simple and convenient classifications to measure gross reaction of airplane passengers to vibrations here proposed as a standard for aircraft.

Many curves established by these investigators fit closely with those shown in Fig. 1.

The results obtained by Jacklin and Liddell are in close agreement with more than 90% of the *barely perceptible* curve No. 1. Reactions of approximately 100 men between 17 and 27 years old, on a hard seat mounted on a vibration table giving a nearly simple harmonic motion, were measured by these investigators. Later Jacklin tested the reactions of about 100 young women.

The curves established by Constant are also in general agreement with those of the proposed standards. These lie in Regions 4 and 5, between *disagreeable* and *exceeding disagreeable*. Agreement is best at low frequencies. A "large number" of subjects was tested on a beam hinged at one end, driven by a simple harmonic oscillator at the other end. Constant tried to establish the threshold of comfort for aircraft vibrations.

Reiher and Meister made the most comprehensive single investigation in the range of amplitudes and frequencies of interest to the aircraft industry, and their curves do not deviate from the corresponding

proposed standard curves by more than one Region. They indicate a greater sensitivity, however, in Regions 0, 1, and 2 than do the proposed standards.

Alexander *et al* reported the effects of acceleration level upon motion sickness, and their agreement with the curves in the proposed standard is excellent. They tested 120 Naval cadets on a reversible elevator.

Fingertip sensitivity curves drawn by Geldard were constructed on the basis of his recomputations of data developed by four other investigators, Hugony, Setzepfand, Gilmer, and Knudsen, and shows the average of those four findings.

A series of tests conducted by the Douglas Aircraft Co., Inc., showed excellent agreement with the proposed standard curves. The Douglas graph classifies five airplanes into three comfort regions corresponding to the "smooth," "acceptable," and "rough" of the five experienced observers (pilot, copilot, and three vibration engineers.) The response to the smoothest airplane was found to be in the *barely perceptible* region, and the two rejected airplanes are in the *slightly disagreeable* region. In these tests a vibration pickup was mounted on the floor of the airplane, during flight tests with single engine operation.

## NAVAL AIR POWER

cont. from p. 31

upward trend of aircraft cannot be accommodated indefinitely.

The Navy can stay in the same performance brackets as its shore-based opposition, using jet propulsion or whatever the art makes possible, but can do so only until it reaches a hard and fast upper limit of gross weight and size.

I would like to repeat what I said in the beginning - as long as ships can be used to do things in war which cannot be done as well, if at all, in other ways, ships should be developed and employed to that end. Global coverage by aircraft is technically practicable within ten to fifteen years, but even then only from presently-held bases which might be lost.

For a long time to come, the airplane carrier, used in quantity, can put in the air in critical strategic parts of the globe, an air force of much higher performance than can be employed in those same strategic locations from shore bases.

I have not touched on guided missiles, nor on atomic energy. They appeared in only their embryonic stages in the Great War, even though those appearances were portentous. Their development belongs to the future. The same fundamental considerations which I have discussed as controlling and governing naval usage will, however, apply to them as well.

Although these fields are full of glamour and

their pioneers have the advantage of better advertising than those of the past, they are not yet out of the pioneering stage and can be expected to have the usual troubles that go with pioneering.

The development of that sort of equipment is not cheap; nor is that of the modern jet-powered inhabited airplane with all of its complex components, which is already knocking at the doors of the transsonic barrier. If the national economy requires curtailing our appropriations to a level well below the capacity of our industry to accomplish those developments, we must pick and choose the best we can in an expanding field of possibilities, in a world which is not everywhere limited by the same economy.

There is one final thought I would like to leave. You who are connected with the aircraft industry know better than I what is its real capacity for development work. I think that that capacity is high, and that unless and until peace is assured, none of you should be required to disrupt your development organizations because of false economy in the field of aviation for the armed forces.

I am sure you will help this country in the American tradition of competition by turning your efforts to creative, imaginative work, and by contributing to the maximum in conception and understanding, as well as in the detailed excellence of your performance.

# AIRBORNE AIRCRAFT

# ARRESTING

# GEAR

**P** RINCIPLE of this arresting gear is based on the energy-absorbing qualities of specially treated undrawn nylon material named Unolyn, which has the property of stretching under load to several times its original length, absorbing energy as it stretches, but without building up substantial recoil as a natural rubber band would do. The load *versus* elongation characteristics of this material are shown in Fig. 1.

The material stretches elastically about 25%, after which "drawing" takes place. In drawing, its long chain molecules are changed from a helter-skelter formation to a parallel arrangement with a reduction in cross-sectional area in proportion to the degree of elongation.

This drawing force continues uniformly to about 150% elongation, whereupon the force gradually begins to increase so that at 300% elongation the load is nearly doubled. Here the Unolyn has reached the breaking point. The total energy required to fully draw the material to the breaking point is approximately 50,000 ft-lb per lb of nylon, and appears in the form of heat, raising the temperature of the material about 150 F.

In actual applications only a part of the total energy capacity is used, the balance being held in reserve as a safety factor. In arresting gear applications, where possibility of breaking the plastic material would not be serious, a figure of 40,000 ft-lb per lb working range is used. In pick-up, where failures would be critical, a much higher factor of safety is used.

By selecting a webbing of proper cross-sectional area, any desired draw load can be obtained; and by selecting the proper length any amount of kinetic energy absorption may be accomplished.

\* Paper, "Airborne Aircraft Arresting Gear," presented at the SAE National Air Transport Meeting, Chicago, Dec. 3, 1946.

EXCERPTS FROM A PAPER\* BY

**A. B. Schultz**

Chief Engineer, All-American Aviation, Inc.

In the arrest of the Cub airplane, for example, a 1060 lb draw load, represented by a 3 in. wide by 3/16 in. thick webbing is used which stops the Cub at slightly less than 1 *g* deceleration. A length of 42 ft is adequate to absorb the kinetic energy of the Cub at speeds as high as 80 mph.

While the airplane is still airborne and at any ground speed up to 80 mph, a spike, shown in Fig. 2, is driven into the ground like a rocket. This anchors one end of the Unolyn to the ground. The other end is attached to the aircraft. As the airplane proceeds beyond the spike, the webbing

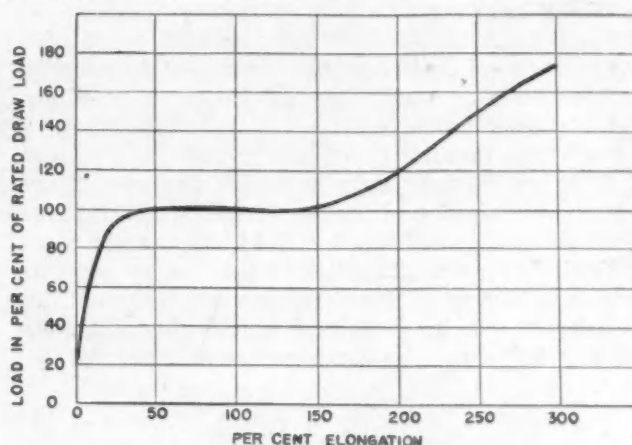


Fig. 1 - Typical load-elongation curve for Unolyn webbing

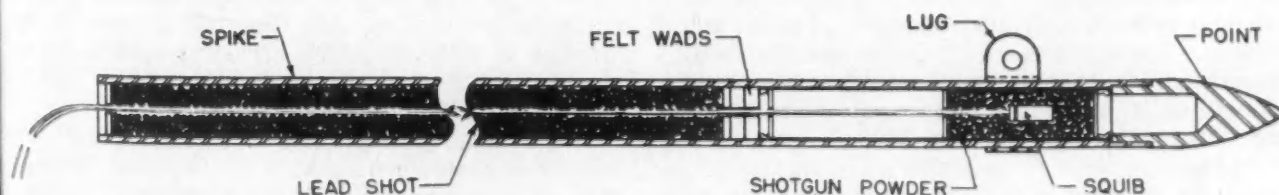


Fig. 2 - Rocket-propelled anchor which is fired from aircraft to secure one end of Unolyn webbing to the ground

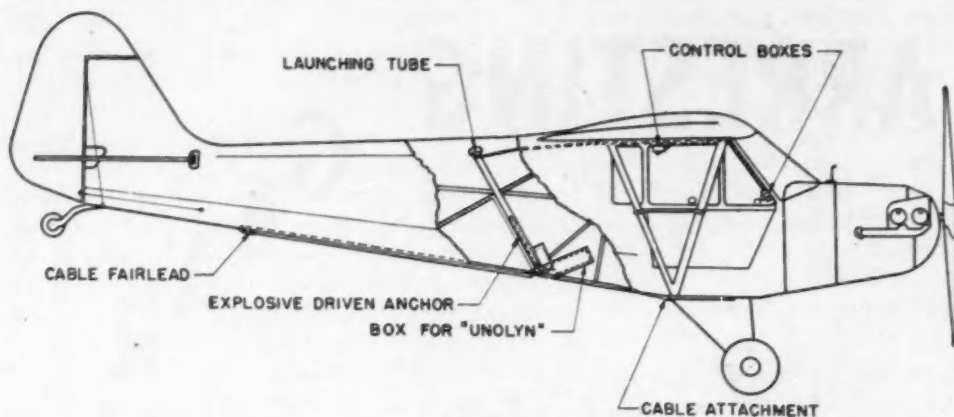


Fig. 3 - Schematic view of installation of arrester equipment in Piper Cub

is stretched and its retarding force smoothly decelerates the airplane to a stop in a short distance.

The total distance from the spike to the nose of the airplane is usually 150 ft to 200 ft. The rate of deceleration is approximately the same as the quick stop of an automobile on dry pavement. No special harness is required for crew or passengers, and no special piloting technique is required.

The complete installation in the Cub is shown in Fig. 3. The total weight of the installation is 22 lb and the equipment is submerged inside the fuselage. The effect on the c. g. is unimportant and no changes in the primary structure are necessary.

The same arresting gear principle could also be used on large transport aircraft. Although equipment for large aircraft has not yet been developed and the problem of anchoring to reinforced concrete runways has not been completely worked out, engineering study has disclosed no problems which cannot be solved.

Here the possibility of saving life and equipment is much more substantial as the speeds are higher, weather and surface conditions become more marginal, and landing field lengths are more critical. Its prime function would be to stop an airplane having engine failure on take-off, or overshooting a landing, and not having sufficient runway left to make a normal stop.

#### Suggests Use on DC-3

If the DC-3, at sea level and 25,200 lb, were to be recertificated under the new provisions of CAR, it would provide a typical example of what could be done. The single engine failure condition would require a 3900-ft field which could be reduced to 2500 ft with JATO for emergency standby. The "accelerate-stop" distance of 3700 ft could easily be reduced to 2600 ft with the arresting gear. In the determination of the "normal effective runway length for landing," the minimum possible landing run of 2080 ft is established as 60% of

the total, thus the DC-3 would require a 3460-ft landing runway. For the occasional emergency landing in an "alternate" field, the factor is let down to 70% allowing a runway only 2970 ft long. It seems only reasonable that an airplane equipped with an arresting gear as a standby should be allowed a further reduction to an 80% factor which would result in a 2600-ft runway. Thus, the JATO-arresting gear equipped DC-3 airplane, instead of needing a 3900-ft field would be able to operate under CAR from a 2600-ft field at maximum weight.

#### Idea Projected

Admittedly, when operating from the 3900-ft field the airplane would stand to lose about 935 lb of payload, equal to approximately 500 lb of arresting gear and 435 lb of JATO. However, when the field length gets down to 3400 ft the payload would be about the same in each case. At 3000 ft the normal airplane would suffer a substantial penalty. At 2600 ft our specially equipped airplane would still be taking off at 25,200 lb and with over a ton more payload than the standard ship. The case could easily be extended to show that on fields even shorter than 2600 ft the special ship could still carry economically feasible payloads.

Due to the fact that all DC-3's are now operating under the old CAR, allowing flights from shorter fields than the new transport regulations call for, the preceding discussion does not bring home a full realization of the problem. The important point is that if the requirements of currently effective Civil Air Regulations were to be invoked in full, the JATO-arresting gear airplane would be able to operate from fields only 70% as long as the standard ship.

The unusual possibilities of this arresting gear call for serious consideration of its future application. It presents one possible solution to the important question—"How can we operate out of shorter fields and still conform to CAR?"

# New Instrument Measures Piston Temperatures

BASED ON A PAPER\* BY

**A. C. Scholp, G. R. Furman, and P. A. Binda**

TEXAS CO.

**P**ISTON temperatures of high-speed engines can now be accurately determined with the aid of a newly developed contactor, which transmits the voltage generated in a thermocouple installed in the piston to the galvanometer that measures the voltage.

This contactor replaces the mechanical linkage used to compensate for the reciprocating motion, when obtaining temperatures in pistons of low-speed engines. These linkages become too intricate when adapted to high-speed engines.

The new contactor has operated satisfactorily over long periods; its wearing parts can easily be replaced. Other features include:

1. Intermittent contact—because fixed leads through a "grasshopper" linkage break too frequently.
2. Pneumatic plungers—because metal springs, both leaf and coil, weaken and even break from fatigue.
3. Wiping contact—which is superior to perpendicular contact because it permits better penetration through oil and other films on the contact points.
4. Long contact time—as it eliminates using galvanometers of extreme sensitivity.

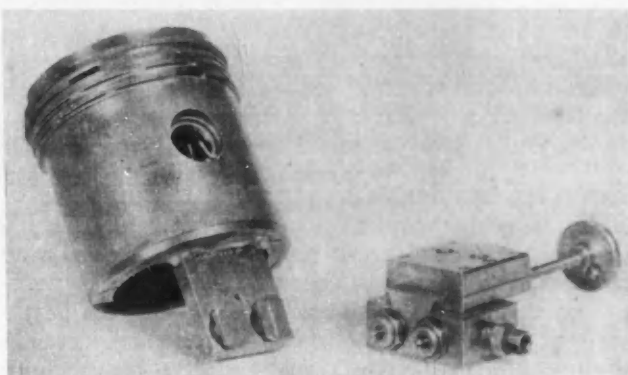


Fig. 1 - Single-point piston thermocouple contactor mechanism

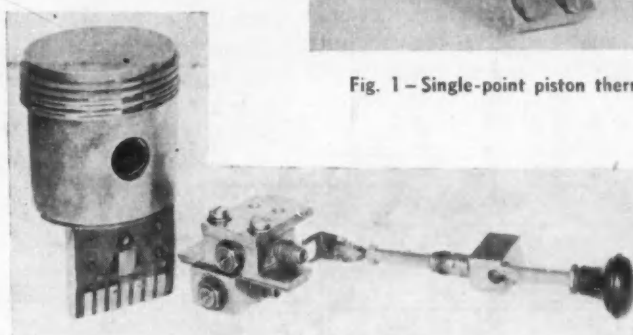


Fig. 2 - Multipoint piston thermocouple contactor mechanism

5. Minimum displacement of contact points—as large displacements are conducive to bouncing contact and less effective contact time.

6. Retractability of contact points—because the life of a pickup can be extended by withdrawing it when not in use.

## Types of Contactors Developed

Two models have been developed, the single-point contactor shown in Fig. 1 and the multipoint contactor shown in Fig. 2. Basically, the device consists of a thermocouple, contact elements, and a contactor. The thermocouple terminals—flat, inclined surfaces or shoes—are fastened to an extension screwed to the bottom piston skirt reinforcing rib so the contact element surfaces are located

\*Paper "Instrument for Piston Temperature Measurement," was presented at SAE Annual Meeting, Detroit, Jan. 9, 1947.

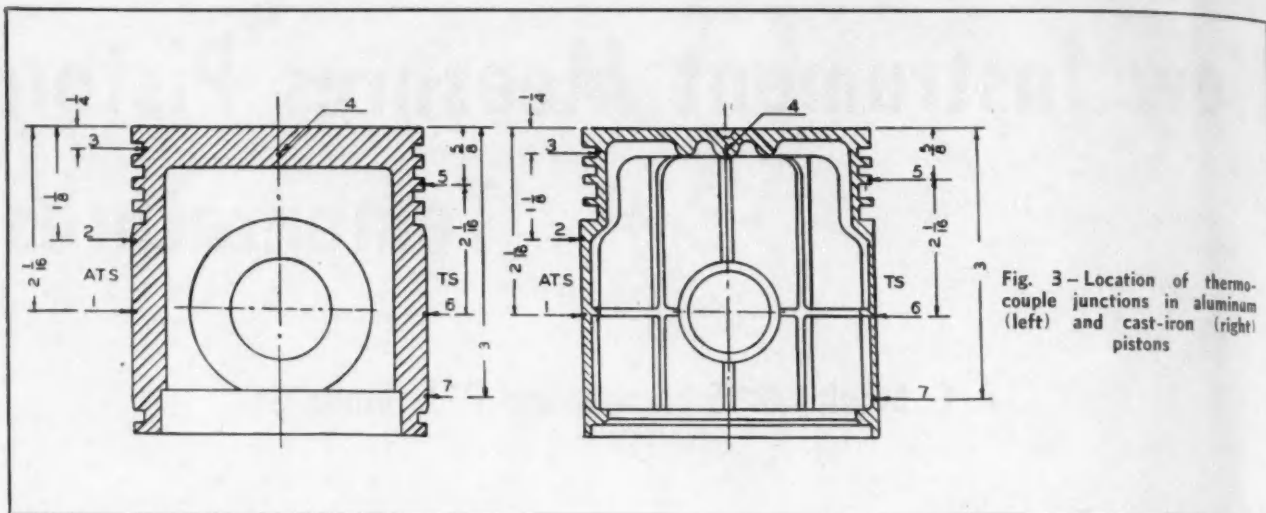


Fig. 3 - Location of thermocouple junctions in aluminum (left) and cast-iron (right) pistons

below the end of the cylinder liner at bottom dead center. The shoes are made of high carbon steel, hardened to 300 diamond Brinell.

The multipoint contactor is identical in principle to the single-point type, except that one contact point is movable and placed below instead of beside the other contactor, as can be seen in Fig. 2. Instead of two adjacent shoes, a single shoe was utilized for all the iron thermocouple leads, whereas the constantan leads were connected to seven shoes placed in a line below the upper shoe. In this manner, the lower contactor, could be moved successively into contact with the seven shoes, each

contact bringing into the circuit the thermocouple attached to that shoe.

The contactor unit is installed in the crankcase and the shoe holder is attached to the piston so that contact between plunger tips and shoes is made only for that portion of the stroke when the piston is near bottom dead center. The contactor unit is connected to both air pressure and vacuum lines through a solenoid actuated, three-way valve. When readings are desired, the solenoid is actuated to move the valve to introduce air behind the plunger. On release of the solenoid, the valve returns to its normal position, so that the vacuum retracts the plunger to a noncontacting position. Since this unit is utilized in a remote position,

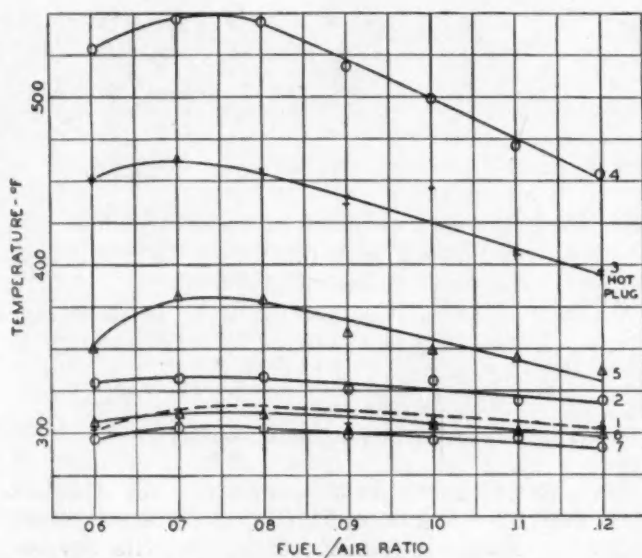


Fig. 5 - Effect of change of fuel-air ratio on aluminum piston temperature (jacket temperature = 225 F, manifold pressure = 40 in. of hg absolute, other test conditions as in Table 1)

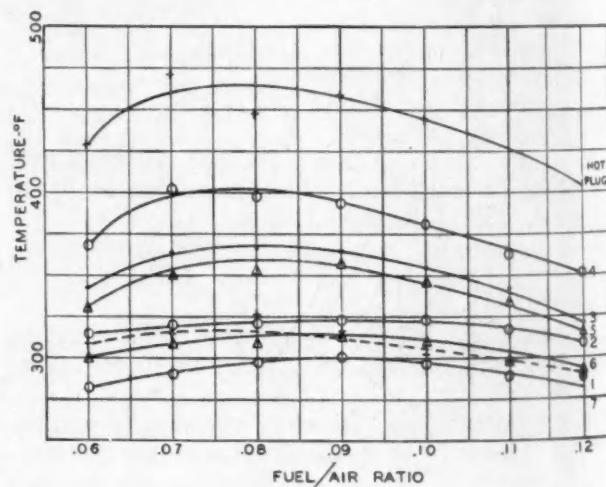


Fig. 4 - Effect of change of fuel-air ratio on cast-iron piston temperature (jacket temperature = 225 F, manifold pressure = 40 in. of hg absolute, other test conditions as in Table 1)

contact is for no longer than is necessary to obtain readings.

### Test Results

Tests were run on a high-speed CFR valve-in-head engine operating under the conditions given in Table 1. A cast-iron piston and also an aluminum piston were used, fitted so as to give the same compression ratio in both cases. The thermocouple locations on these pistons are shown in Fig. 3, which also details the construction of the pistons used.

An insulated thermocouple called a hot plug was inserted into the combustion space through a spark-plug hole to give a relative indication of the average temperature sustained by a surface at that point.

Fuel-air ratio, jacket temperature, and manifold pressure were each varied separately. Results of varying the fuel-air ratio are given in Figs. 4 and 5.

The curves show that maximum piston temperatures were obtained at the same fuel-air ratio as the maximum hot-plug temperature. As might be expected, the highest temperature was in the piston crown, with decreasing temperatures encountered through the ring belt area down to the piston skirt, where temperatures at all ratios were substantially identical. Trends in both the pistons were the same, except that the temperatures in the top ring belt area and in the crown of the aluminum piston were

Table 1 - Operating Conditions

Cylinder Bore, in.	3/4
Piston Stroke, in.	1
Engine Speed, rpm	1800
Compression Ratio	6.5
Spark Advance,* deg BTC	20
Oil In Temperature, F	188
Approximate Oil Out Temperature, F	200
Air In Temperature, F	190

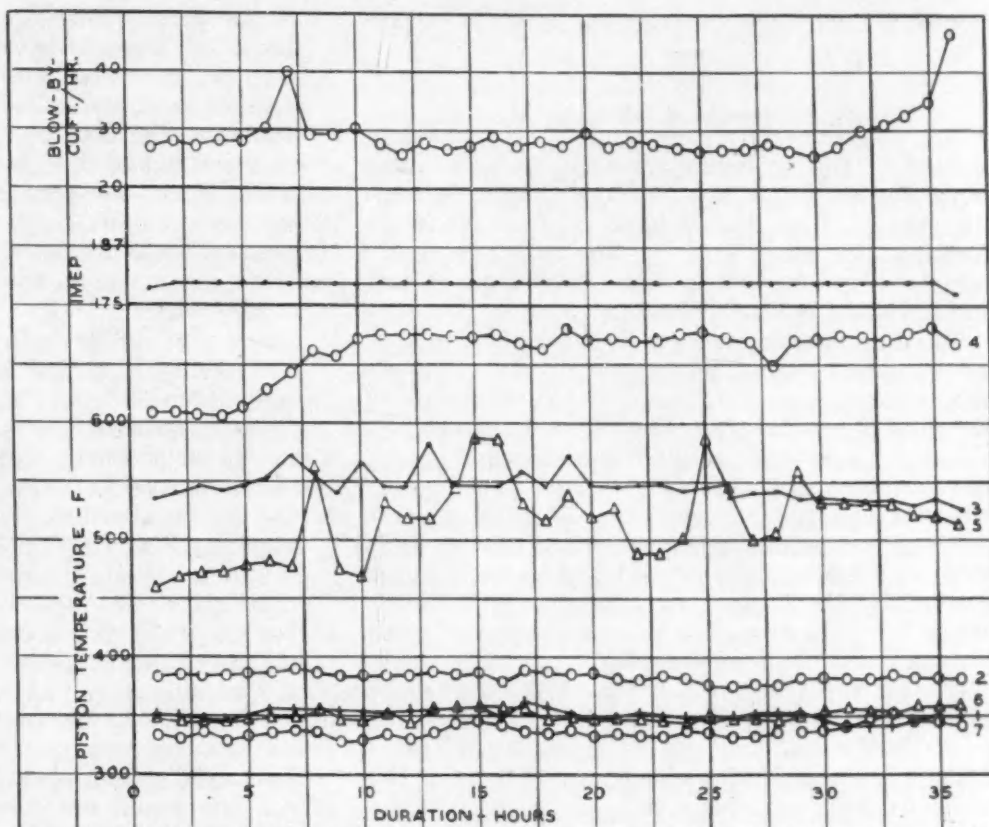
\* Maximum power is realized at a spark advance of approximately 33 deg BTC.

much lower than those for the cast-iron piston, and there was a substantial change in temperature through the skirt area - as may be expected because of the better heat conductivity of aluminum and since the greater thickness of the aluminum piston skirt allowed for better heat conductivity to the skirt area. The temperature of the thermocouple lowest on the piston skirt roughly approximated the jacket temperature. The variation in this thermocouple temperature approximates that of the hotter thermocouples, although to a much less degree and in the jacket temperature range.

An extended run was also made under the same operating conditions, except that a jacket temperature of 360 F, a fuel-air ratio of 0.07, and a manifold pressure of 40 in. of hg were used.

The results are shown in Fig. 6, which indicates satisfactory operation of the instrument. Thermocouple No. 5, although showing erratic readings, was found to be in good operating condition.

Fig. 6 - Piston temperatures and other operating characteristics during 35-hr run (jacket temperature = 360 F, fuel-air ratio = 0.07, manifold pressure = 40 in. of hg absolute)



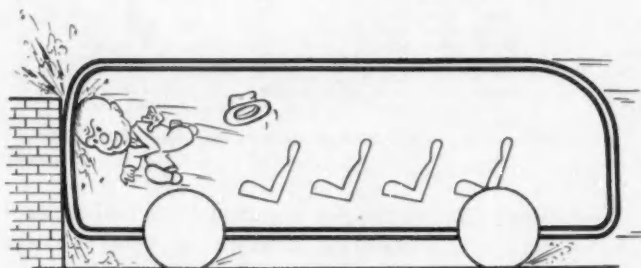


Fig. 1—Very rigid bus structure striking rigid object stops suddenly. Passengers are smashed against interior

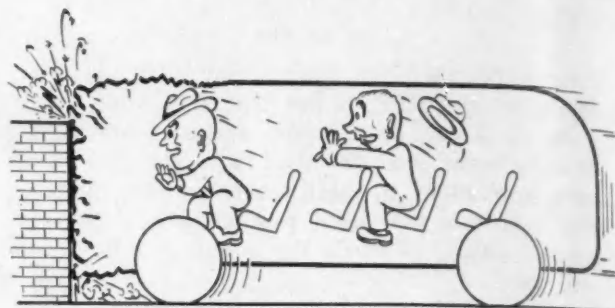


Fig. 2—Less rigid bus structure deforms under impact, cushioning shock. Passengers are thrown forward with less force

**Y**IELD strength in collision and fatigue endurance for ordinary service govern design of the shell component of today's integral coach structure.

Provision for passenger safety in case of collision is a two-sided problem. Failure of the structure may seriously injure those people in the region of impact—deceleration throws all the occupants against obstructions. What is needed is a design balancing the two dangers.

Aside from affording safety in collisions, buses should be rugged enough to withstand a long life of normal service without major failures. This means that the designer must combine all his data on service conditions with stress analysis and laboratory data on the fatigue strength of materials.

#### Strength in Collision

Finding the optimum value of collision resistance for safety is a two-sided problem because the energy of an impact is used up either in deforming the coach structure or in stopping the vehicle. Figs. 1 and 2 illustrate the effects of high and moderate collision resistance.

Standing passengers have been seriously injured by unexpected stops where the deceleration was only about 0.8 *g*. Yet, the collision resistance of our present coaches is several times as great.

Exactly how much collision resistance is needed at each point in the vehicle is hard to define because of the velocity variable. For example, a coach strikes an obstacle, goes out of control, falls 30 ft, and lands on the rear end. The front end is crushed by the impact, but the rear end doesn't fail in the 30-ft drop. The front end appears to be too weak and the rear amazingly strong.

True, if the speed of the bus at the instant of impact was 30 mph, the numerical values of the forces in the collision and in the fall were identical. However, if the speed was 42.5 mph, the collision forces were twice as large as those of the fall.

## Strength Aspects of

The designer must remember, too, that forces resulting from the head-on type of collision also tend to overturn the vehicle. The hazards of rolling must be compared with those of crushing, before the design value of collision resistance is set.

Even in side collision, today's coaches have demonstrated resistance high enough to permit development of the critical overturning moment.

Probably the best approach to the problem is to bring collision strength of all vulnerable components up to the present maximum, which has been fairly satisfactory. Any new design compromises should aim at minimizing injuries to passengers and driver in the various prevalent types of accidents.

#### Designing for Long Life

Second major problem is designing for sufficient fatigue endurance in service. Operators want rugged construction so that no major failures in the body shell, shown in Fig. 3, will occur before normal retirement. Economic basis for their view is the high cost of body repairs.

Almost all service failures happen well below yield stress and are due to fatigue. Possible yield failures are easily avoided because they show up in the experimental model. Fatigue failures are much more difficult to dodge. Although there are plenty of laboratory data on fatigue properties of materials, little is known about stress cycles imposed on parts by service conditions.

Tests runs over a Belgian block road have long served the coach designer as a crude guide to what can be expected of a structure in service.

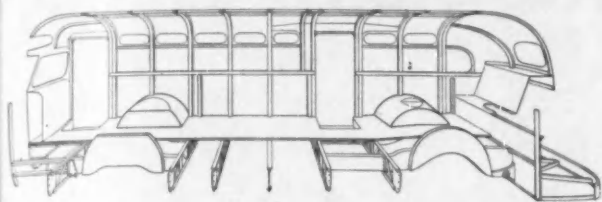


Fig. 3 - Cut-away view of coach shell

# ts of Bus Shell Design

BASED ON A PAPER\* BY

**H. E. Fox** ENGINEERING DEPARTMENT  
GMC TRUCK & COACH DIVISION

corresponds to the natural frequency of the unsprung mass and is induced by roads of moderate, irregular roughness. The higher frequency is close to that of the sprung mass and is induced by rolling roads punctuated by thank-you-ma'am's.

Therefore, it looks as if moderately rough roads tax the unsprung structure; and rolling roads, the sprung structure.

## Cast Iron Is Useful

Stress-raisers such as notches, riveted or welded joints, and abrupt changes in section are watched carefully in designs. In these cases, it doesn't pay coach designers to snub lowly cast iron. Sometimes, the favorable notch sensitivity of cast iron makes it a better material than steel, even though the polished-specimen efficiency as measured by the fatigue endurance-density ratio is lower for cast iron than for steel.

The effect of stress-raisers varies on different specimens of the same part, probably due to small variations in material or processing not detected in inspection.

Special attention is given to possible "trapped stresses." Some stresses may be set up by welds, carburizing, or misalignment of subassemblies even before any external load is applied. These hidden stresses, which don't show up in the design stress calculations, may add to or detract from externally imposed stresses.

The phenomenon of corrosion fatigue is a vicious cycle not to be overlooked in coach design. Corrosion accentuates the effects of stress—not merely by reducing effective area, but also by some means not yet understood. Stress, in turn, accelerates corrosion. In order that the coach shell will remain strong over the expected life of the vehicle, protection against corrosion is planned for all highly stressed parts.

Some reliance is placed on the relief of over-stressing on very rough roads by understressing

concluded on page 53

This has been an expensive method of fatigue testing highly stressed parts to failure; it gives no information on understressed parts.

Fatigue failures have been reproduced and studied in segregated structures in the laboratory. Such data on fatigue endurance could be more profitably applied to coach design if the number of cycles per mile and stresses were known for critical parts. Recently, instrumentation developed for measuring loads and stresses in aircraft structures has been installed in buses. Results so far promise that the method will be a useful tool for correlating information on service failures with data on test specimens.

High on the list of design characteristics which the designer must consider is resonance. Parts such as engine mounts, fuel lines, and accessories may have natural frequencies too close to that of some exciting force. Extreme cases show up quickly, but cases further from the resonant peak are hard to isolate. To correct the condition, either the frequency of the disturbance is changed or the natural period of the part is altered by a change in its design.

Some interesting resonance data have been gathered with aircraft-type load—and stress-measuring equipment on coaches run over the Belgian block road. A typical record of instantaneous loads and stresses on the front and rear suspension structures shows an irregular pattern in which two frequencies predominate. The lower frequency

\* Paper "Modern Coach Structures" was presented at SAE Annual Meeting, Detroit, on Jan. 7, 1947.

# Three Scuff-Resistant Coatings

BASED ON A PAPER\* BY **F. C. Young** HEAD, METALLURGICAL DIVISION, FORD MOTOR CO.

and **B. B. Davis** CHEMICAL ENGINEER, FORD MOTOR CO.

**P**ROTECTING metal wearing surfaces, such as bearings or parts in contact under relatively heavy loads, can spell the difference between successful operation and failure—especially during critical breaking in.

Among the chemical treatments used by the

\*Paper "Scuff and Wear Resistant Chemical Coatings," was presented at SAE Annual Meeting, Detroit, Jan. 6, 1947.

automotive industry to produce wear-resistant surfaces on steel and cast-iron parts are manganese iron phosphate, iron oxide, and caustic sulfur.

This article discusses some specific applications. As yet there is no method of evaluating these coatings. Finding the best treatment for a particular job frequently requires dynamometer or field testing of the finished product.

## 1. MANGANESE IRON PHOSPHATE COATING

The manganese iron phosphate treatment etches the surface and chemically converts it to a non-metallic coating consisting chiefly of iron and manganese phosphates.

The coating bath includes manganese carbonate and phosphoric acid. An oxidizing agent added to the bath converts hydrogen formed to water, preventing accumulation of bubbles on the surfaces

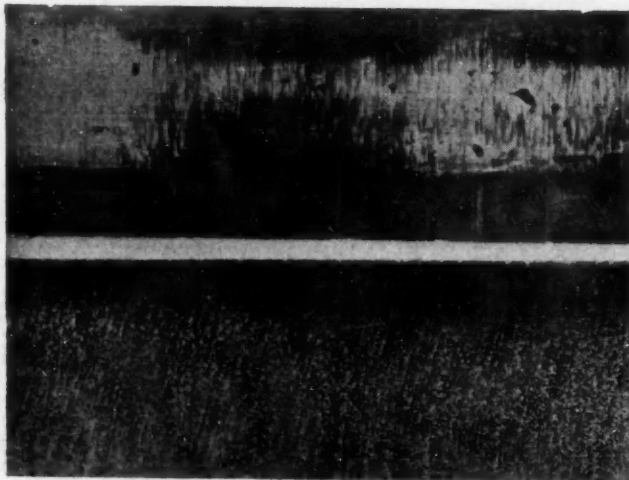
treated. This promotes uniform coating deposition and etch.

Phosphate coating benefits stem from several important properties it possesses. This nonmetallic surface prevents welding, which often occurs in metal-to-metal contact under load. Being absorptive, phosphate coatings promote better lubricant distribution during critical break-in. The bath's etching action pits the base metal. This aids lubrication even after the coating is worn away.

Unit loadings are reduced on processed parts because of increased contact areas. The chemical coating "laps-in" the working surface.

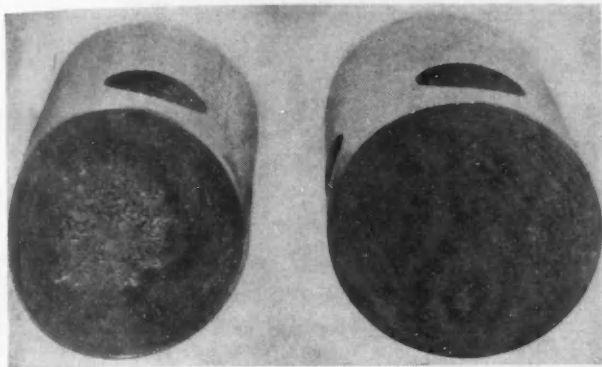
In the case illustrated, the untreated universal joint trunnion, upper photograph, showed scuffing after 5000 miles of operation. Phosphate treated trunnions, as shown in the lower photograph, had a smooth, even surface after 15,000 miles.

Using phosphate coatings in pump manufacturing makes possible the use of stamped soft steel covers and spacer plates with steel in the "as-rolled" condition, without further heat-treatment or hardening. In many cases phosphate coating steel shafts and cast-iron bearings eliminated the need for sleeve bearings.



# gs for Ferrous Wearing Surfaces

## 2. IRON OXIDE COATING



The oxide treatment has been confined to cast or chilled iron parts as the temperatures required for production of the desired oxide anneals steel parts and changes their physical properties.

Tight black oxide on cast-iron parts is produced

in a gas-tight draw furnace or retort below 1100 F. The desired oxides are  $\text{FeO}$  and  $\text{Fe}_3\text{O}_4$ . Problem here is to prevent formation of  $\text{Fe}_2\text{O}_3$  or red rust. This undesirable oxide is produced at temperatures below 212 F, when water in contact with air forms ferric oxide which decomposes to  $\text{Fe}_2\text{O}_3$ .

The desirable oxide is produced by charging dry parts into a furnace at 1100 F in a dry air atmosphere. After the entire load is well over 212 F – it takes about 10 min – steam is introduced to purge all air from the furnace. Temperature of the load is then allowed to rise to 1100 F and held there for 20 min.

Oxide coatings generally are applied to chilled iron followers or tappets and cast-iron piston rings.

Numerous tappet failures on farm tractors were eliminated by oxide-coating the tappet faces. The tappet in the illustration at left is untreated; the one on the right has an oxide coating.

## 3. CAUSTIC SULFUR COATING

The caustic sulfur coating is produced by immersing the parts in a hot aqueous bath of 50% sodium hydroxide by weight and 1% powdered sulfur. Steel and iron parts are given an etched, porous surface covered with a thin film of iron sulfide.

Satisfactory coatings have been produced on cast-iron cylinders and pistons in 15 min; on piston rings in 30 to 45 min; and on more highly resistant materials in 30 to 60 min.

Microscopic examination of caustic-sulfur coated surfaces show formation of a slight etch with a dark, matte finish. Tool marks and scratches on finely machined and ground surfaces are removed to some extent. The illustration shows this. The untreated cast-iron piston ring, at left, is not nearly as smooth as the treated surface at right.

This chemical film performs an important service by preventing welding. It also aids lubrication by increasing oil wettability.

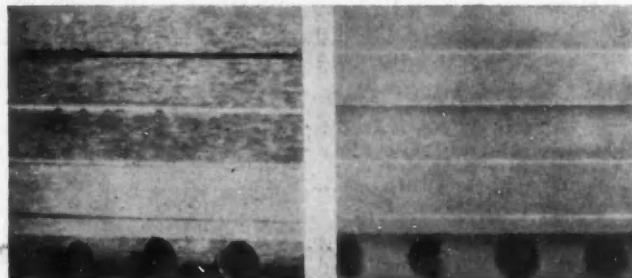
In one case, untreated standard Timkin cups, made of case-hardened SAE 4615 steel, failed at a 1000-lb load under scuffing tests. The caustic-sulfur coated cups carried 5700 lb without failure. These tests indicate the advantages of scuff-pre-

vention treatment for parts such as steel gears, camshafts, and tappets.

In another instance, untreated cast-iron cylinder liners from diesel engines examined after a 6-hr break-in period showed excessive scuffing. This was caused by welding under pressure of metal to the rings, gradually scuffing the entire liner surface as the ring worked around the piston groove.

Liners removed after the 6-hr break-in from engines using treated parts showed smooth and uniform surfaces with no scuffing or scratching.

Disassembly of several hundred diesel engines in service showed the treatment to have reduced scuffing to about one-tenth that of untreated parts during break-in.



# NEW ELECTRIC RETARDER Promotes at Higher

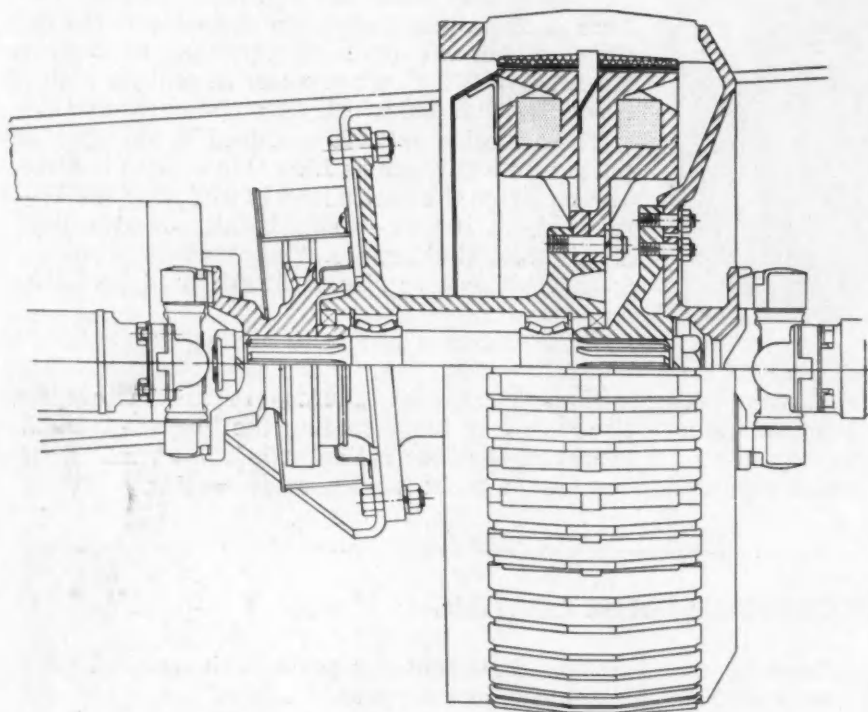


Fig. 1—The energy dissipator retards the vehicle by generating current with energy absorbed and immediately converts it into heat. Fan blades integral with the armature circulate air which dissipates the heat

(This paper will be published in full in SAE Quarterly Transactions)

**A** newly-developed energy dissipator, supplementing vehicle brakes, permits faster speeds with inherent safety and minimizes brake wear.

## Product Description

This device, shown in Fig. 1, is constructed of a stationary electric field element mounted on a nonrotating member of the vehicle, and a rotating armature or drum connected to the propeller shaft. It operates much like a generator with a short-circuited armature; electric currents are generated within the drum, not in any windings.

The eddy-current brake itself has no commutators, brushes, or rotating windings. Since magnetism alone produces braking, there is no wear.

A battery-charging type generator, belt-driven

from the propeller shaft, excites the eddy-current brake. Generator speed varies with vehicle speed, simplifying brake control and adjustment.

Fig. 2 shows the dissipator mounted on a cross member of the trailer frame. The necessary control installation within the cab is shown in Fig. 3. The knob on the left above the windshield controls the speed at which the dissipator cuts in. A switch on the accelerator pedal is closed when the pedal is released and is opened by a mere touch on the pedal. If the control knob is set for a cut-in speed of 30 mph and the vehicle speed is 35 mph when the accelerator is released, the dissipator immediately cuts in and builds up to full torque.

A similar switch on the brake pedal closes when the pedal is touched and the dissipator cuts in regardless of the knob setting. Release of the accelerator cuts the dissipator in; it cuts out again when the unit slows down to a speed slightly below the cut-in speed.

\* Paper, "Energy Dissipators Auxiliary to Brakes," was presented at SAE Annual Meeting, Detroit, Jan. 6, 1947.

# SAFETY

## Vehicle Speeds

But when the brake pedal is touched and held, the dissipator cuts in and continues to operate at approximately full torque until the vehicle has slowed down below 14 mph. Then it dies out gradually as the speed slows down further. More pressure on the brake pedal brings the wheel brakes into action.

### Retarder Results

Equipping trucks and buses with such an eddy-current brake installation can effect:

1. Increased schedule speeds so that the vehicle can make more trips per year, at the same time insuring greater safety;
2. Decreased maintenance costs.

Maximum safe speed is governed by the vehicle's ability to dissipate heat developed. Energy built up in descending a hill or stopping the vehicle on the level can be absorbed by engine friction or by brake friction.

Key to maximum speed boils down to the amount of heat the brake can get rid of. Applying brakes continuously, as in coming down a hill or in making several quick, successive stops in city driving, can easily build up heat in the brake faster than it can be dissipated. If this happens, the brake gets hot. Hot brakes fade, decrease in effectiveness and a lowered safety factor results.

Since heat build-up is an outstanding brake nemesis, let's see what it amounts to without the auxiliary dissipator to relieve the wheel brake of its burden.

In the case of a dual-tire wheel loaded to 10,000 lb, rolling down a 7% grade at 10 mph, enough heat is generated in balancing 6% of that grade to evaporate 5 gal of water per min (16 hp). Since this heat increases with speed, the heat at 20 mph would be twice as much, and at 40 mph it would be four times as much—enough to evaporate 20 gal of water per wheel per min.

Suppose we now install a 16½ x 7 brake on this same wheel—about the largest you can get on most units. This gives a load per square inch of active drum surface of 27.5 psi. Going down a 3-mile grade of 6%, the brake must do the same amount of work regardless of the speed.

BASED ON A PAPER\* BY

**J. George Oetzel**

Executive Engineer, Warner Electric Brake Co.



Fig. 2—This is how the energy dissipator is mounted on a trailer

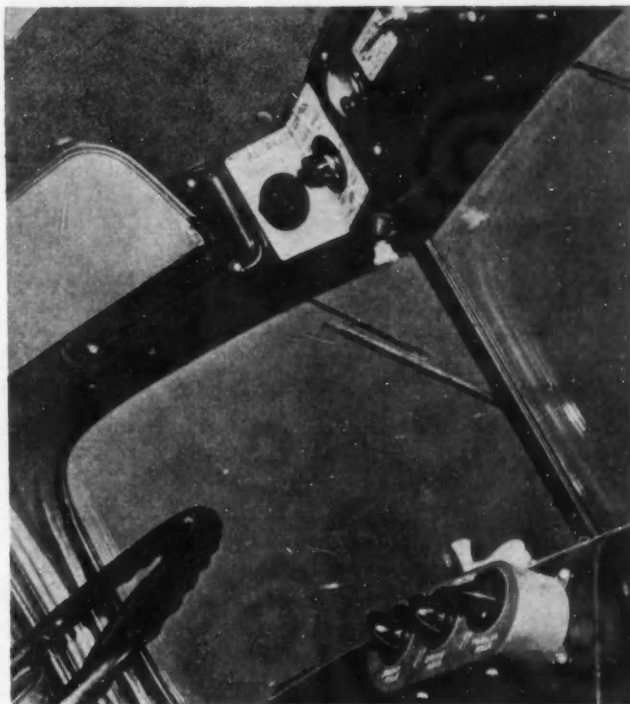


Fig. 3—The driver can preset the knob at the upper left for the speed at which he wants the retarder to cut in. The knob to the right of the speed control permits the driver to select the dissipator's maximum braking efficiency. He can set the braking effect light for a light or no-load condition and full for a heavy load

But what makes the big difference in drum temperature is the length of time heat is poured into the drum. The slower the vehicle descends the hill, the slower the heat is developed and the more of it the drum can get rid of. This 27.5-psi drum

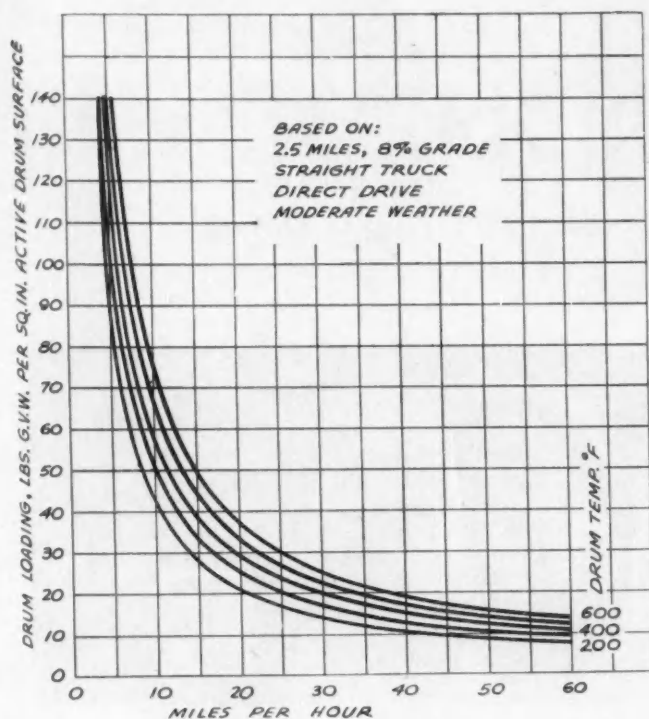


Fig. 4—This chart shows the importance of holding down speed with high drum loadings—as when using only the trailer brakes instead of all the brakes in the train

loading produces a drum temperature of about 600F at 40 mph, but only a 375F temperature at 10 mph. (This is true only when starting down the hill with cold drums. If they are hot to begin with, they will be correspondingly hotter at the bottom.)

We can determine maximum allowable speed on

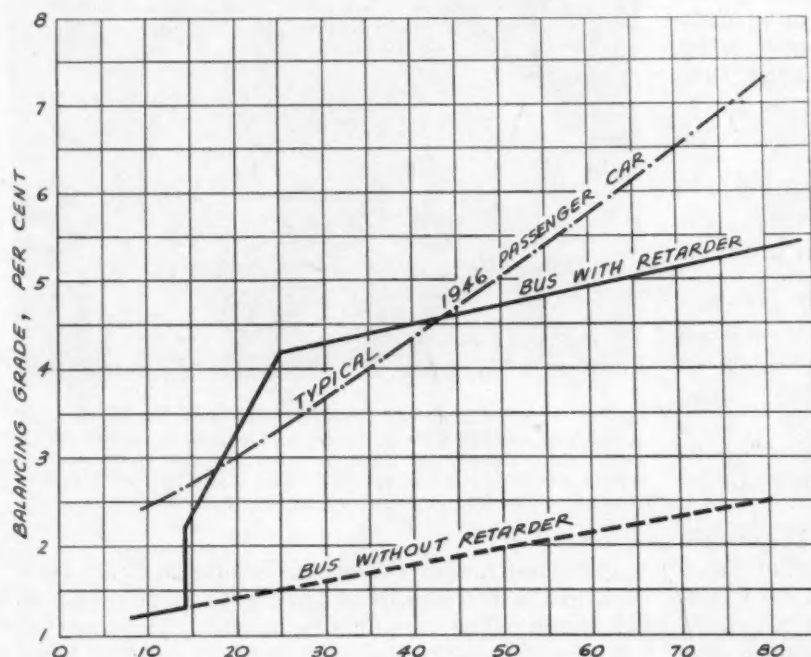


Fig. 5—How a bus with and without an eddy current brake compares with a passenger car in balancing grade

grade by relating it to drum loading and temperature from the formula

$$V = \frac{K}{HW}$$

Where:

V = speed on grade in mph,

H = % of grade,

K = gross vehicle weight per square inch of active drum surface.

Fig. 4, prepared from data obtained in mountain tests applied in this formula, demonstrates the importance of holding speed down with high drum loadings.

For example, using all brakes on the train of a tractor-trailer, average drum loading of all brakes is 24.2 psi. With only trailer brakes applied, drum loading is 63.3 psi. Assuming a brake temperature of 300F, Fig. 4 tells us that the allowable speed for the "all-brake" condition is about 20 mph, shrinking to about 7.5 mph using only trailer brakes.

Because brakes are the major limitation to higher speeds, hope is always held out for a new longer-life brake drum or lining material. But this is not the answer. Whatever the material, brakes of a given size must run hotter if they are to dissipate more heat.

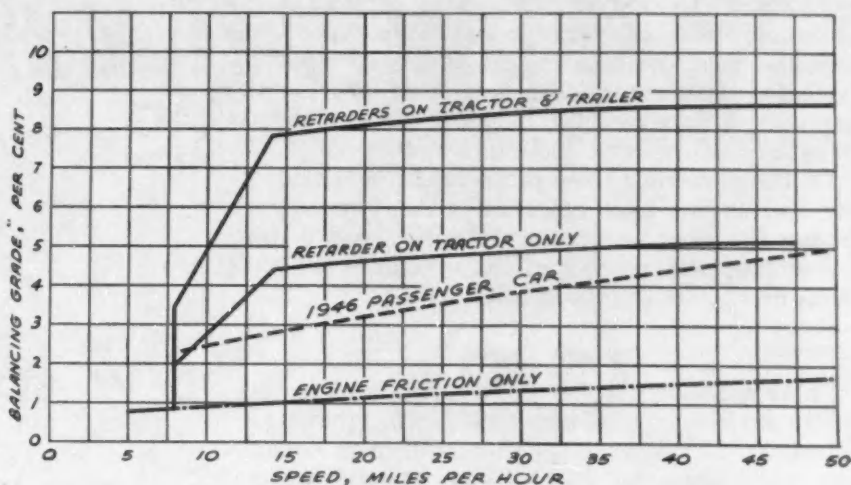
Brakes cannot be made much larger; the enormous amount of air needed to dissipate so much heat cannot be circulated through a wheel brake. It's not practical. What is needed is a device that will assume part of this energy-absorbing burden and readily dissipate the heat. That's why the most feasible alternative is the use of energy dissipators located outside the wheels

and auxiliary to the wheel brakes.

Fig. 5 shows how effective a dissipator can be on a bus and compares the bus—with and without eddy current braking—to a passenger car. According to this chart, a bus at 50 mph can balance a maximum grade of 2% without a retarder. With a retarder, this same bus can run safely at 50 mph over a 4.7% grade.

On the straight-away the retarder can also prevent excessive slowdowns and brake wear. In city driving, brakes of a truck or bus usually must be applied to slow down when overtaking traffic and waiting for an opportunity to pass. But with the dissipator, simply tak-

Fig. 6—Grade balanced by engine and rolling friction of a typical passenger car is compared here with that of a tractor-trailer using engine friction in high gear, with one and both dissipators in operation



ing the foot off the accelerator will cut in the retarder without necessarily touching the brake pedal.

Another example of higher permissible speeds with eddy-current braking is given in Fig. 6. Performance of a tractor-trailer, with both one and both dissipators in operation, is compared with that of a 1946 passenger car. One of the things it demonstrates is that a retarder on both the tractor and trailer permits higher speeds than just a retarder on the trailer.

Let's see what happens with a 45,000-lb vehicle going down a 10% grade both with and without energy dissipators.

Vehicles of this kind are being driven down such grades, two or three miles long, every day on wheel brakes alone, but at low speeds with considerable wear and tear on engines, transmissions, and brakes. With the largest possible brakes and a 450-cu in. engine, this 45,000-lb. vehicle should be brought down the 10% grade in "two gears under direct" drive at 10 to 16 mph, using all brakes.

But many drivers will come down in "one under direct" at 12 to 20 mph or even higher, consuming that much more brake lining. They will run out

the last part of the hill at 50 to 60 mph to save some brake lining and to help them up the next hill, or to make up a little time.

concluded on page 60

## ARGUE ECONOMICS OF EDDY CURRENT BRAKING

Based on discussions by

**JULIUS GAUSSOIN**

Silver Eagle Co.

**E. P. COHN**

Atlantic Refining Co.

**R. K. SUPER**

Timken-Detroit Axle Co.

**AUSTIN M. WOLF**

Automotive Consultant

Energy dissipator pluses balanced against its minuses of weight, cost, and space penalties as well as allied braking problems are argued by Super, Gohn, Wolf, and Gaussoin.

Added weight of the installation invites concern because it reduces payload. A general rule-of-thumb figure, according to Gaussoin, is \$1.00 per lb per year lost in payload revenue for each additional pound of chassis weight.

Taking a specific case, Gohn shows that adding 1000 lb to a tank truck, operating up to maximum gross vehicle weight, reduces payload by some 150 gal. Assuming an over-the-road operation, this loss totals about \$400 per year.

(In view of recent design developments, Oetzel estimates the weight of a tractor or truck retarder installation to be about 400 lb, including generator and controls. An axle-mounted trailer unit, he says, should

weigh about 300 lb more than the dead axle it replaces.)

Super points out that tangible cost savings through improved performance must justify the added weight and initial cost of this equipment. A similar product, electric braking for trolley coaches, met with universal acceptance only when advantages such as tripled and quadrupled lining mileage could be reconciled with first cost.

Spacewise, these propeller shaft brakes appear limited to vehicles with reasonably long propeller shafts. Short shafts on tractors with short wheel bases prohibit the use of such auxiliary brakes. Similar space limitations may rule out rear-engine-over drive-axle buses as potential energy dissipator customers.

The general load shift problem receives attention from all the discussers. Sudden stopping transfers weight to the front end and critically overloads it. Wolf believes that front-end braking capacity has not kept pace with requirements of increased road speeds. He sees proper mounting and positioning, as with individual-wheel suspension, as the key to truly efficient front braking and wheel control.

Gaussoin takes the opposing view, arguing that front brakes—especially on 6-wheel trucks and tractor-trailers—decreases efficiency of steering control. He advocates elimination of front-wheel braking as a much-needed safety measure.

**S**UCCESSFUL car engine cooling stems from a compromise of variable operating conditions and the best combination of the system's components. Laboratory and field tests provide the engineer with a tool for blending these elements to satisfy on-the-road cooling demands.

Of the numerous tests performed, radiator testing and engine heat rejection measurements are among the most important. Finally, road testing the cooling performance of the system is the final check on the laboratory results.

## Radiator Testing

There are several laboratory methods of testing radiators in common use today throughout the industry. The method to be described is considered very accurate and affords a most precise control for both experimental and production testing. Fig. 1 is a schematic view of the type of test apparatus employed in this method.

The apparatus consists mainly of a duct arrangement into which the radiator to be tested can be

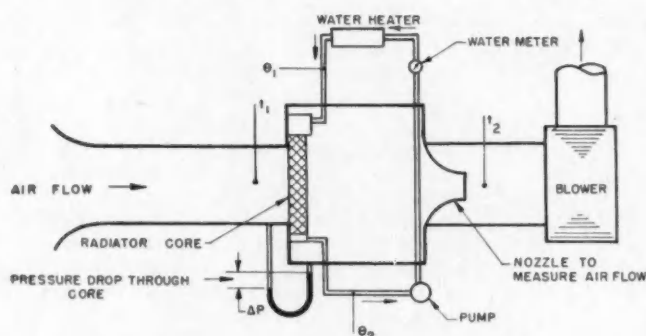


Fig. 1—This setup gives accurate control for testing radiators and mating them with other cooling system components

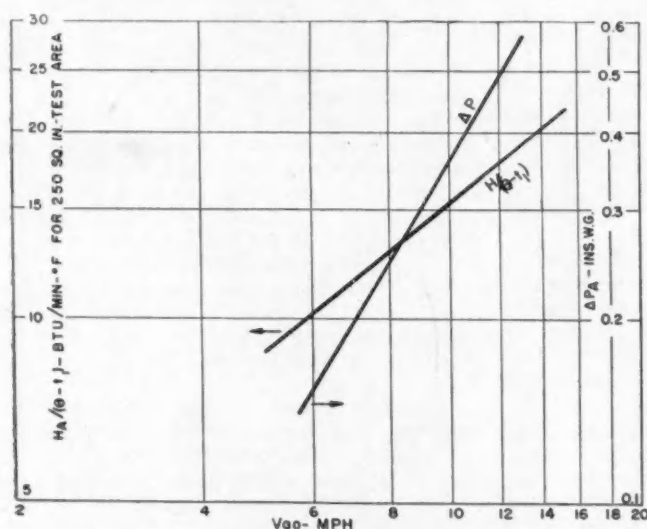


Fig. 2—Radiator test tunnel data plotted to show heat transfer and pressure drop across the radiator

EXCERPTS FROM A PAPER\* BY

## B. W. BOGAN

Head, Engine Cooling Laboratory, Chrysler Corp.

placed so air can be directed through the core while the volume and temperature of the air are closely controlled. Some form of hot water heater and a pump are necessary to heat and circulate water through the core.

With this test apparatus, it is possible to obtain a heat balance between the "air" side and the "water" side.

The heat of the "air" side is equal to the specific heat  $X$  the airflow in lb per min  $X$  the temperature rise; moreover, it is also equal to the specific heat of the water  $X$  the amount of circulated water in pounds  $X$  the differential between the temperature of the ingoing and outgoing water.

An important factor to be observed during the test, particularly when tests are made to match up a radiator with a particular grille and fan combination, is the air pressure drop ( $\Delta P$ ) across the radiator. The drop in air pressure indicates the restriction offered by the radiator to the passage of air.

Since, in a vehicle in motion, the force causing air to flow through the radiator depends on the speed of the vehicle, it is important that the restriction of the radiator be kept as low as possible consistent with good heat transfer.

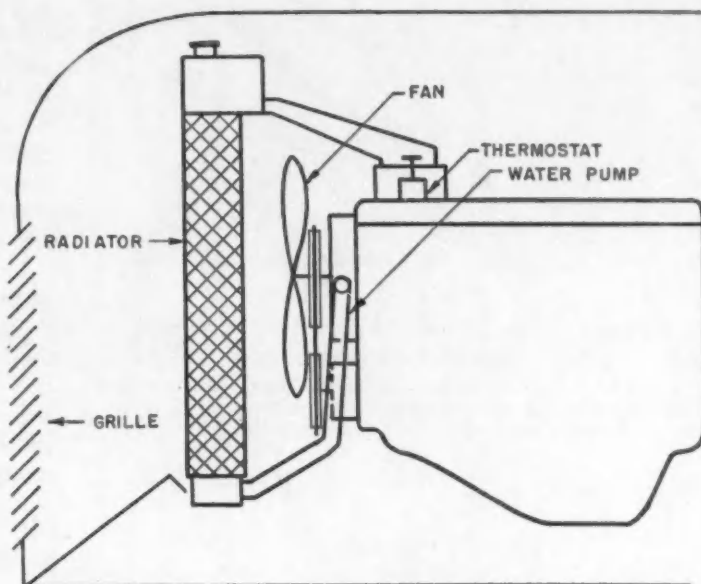
A typical curve sheet obtained by testing a radiator in the tunnel just described is shown in Fig. 2. In this curve, the heat transfer, in Btu per min per deg temperature difference between the average water temperature and the entering air temperature for a 250-sq in test area, is plotted against the air velocity ahead of the test section expressed in mph standard air.

The air pressure drop across the radiator in inches of water is also plotted against the air

\*Paper "Passenger Car Engine Cooling," was presented at SAE Detroit Section, Feb. 3, 1947

# the SCENES TESTING

## of Car Cooling Systems



velocity in mph standard air. Plotting against mph standard air, is, of course, the same as plotting against air weight. Plotting on log-log paper gives straight lines over the range of air speeds tested.

The slope of the  $\Delta P$  curve is less than 2 and varies between 1.55 and 1.75, depending on the core type. The slope of the heat transfer curve varies between 0.65 and 0.85, also depending on the core type. For a typical production core, the  $\Delta P$  slope is 1.70 and the heat transfer slope is 0.78.

The accuracy of such tunnels can be conveniently held to  $\pm 1$  to  $1\frac{1}{2}\%$ . In addition to the value of these tunnels for experimental work, cooling engineers are able, through their use, to keep a close check on the quality of radiators used in production. Besides enabling the engineer to determine the heat transfer and the air pressure drop, such things as the use of worn-out tools or faulty workmanship can be detected through analysis of the test results.

### Engine Heat Rejection

Engine heat rejection is the amount of heat rejected by the engine and transferred to the coolant circulated through the cylinder block and the cylinder head. This is the heat that must be dissipated by the radiator. Therefore, it is highly desirable, whenever possible, to know something of the heat rejection characteristics of a particular engine and also the exact amounts of heat rejected under various operating loads.

The fuel used in today's engines at wide open throttle (W.O.T.) is converted approximately as follows:

- 25% - power or useful work,
- 25% - heat rejected into the coolant in the cylinder jacket and head,
- 50% - exhaust heat including small radiation losses.

Some years back, engine heat rejection was neither measured nor generally considered with respect to the study of the cooling system as it is today. While it is true that a cooling system can be worked out by practical methods without knowing the exact heat rejection of the engine, these methods would entail considerable trial and error and would require a great deal of time.

Whenever it is possible to evaluate the heat rejection of some particular engine, the method for correctly matching a radiator, fan and grille combination for this engine is much more direct and accurate.

In addition to enabling the engineer to match and balance properly the cooling system as a whole, heat rejection tests provide means of checking variations in engines during their entire course of production, to determine the averages and their high and low limits. Heat rejection tests also provide the engine designer with useful data.

Engine design characteristics (such as type of valve arrangement—either overhead or L-head; whether or not any portion of the exhaust manifold is included as part of the cylinder block;

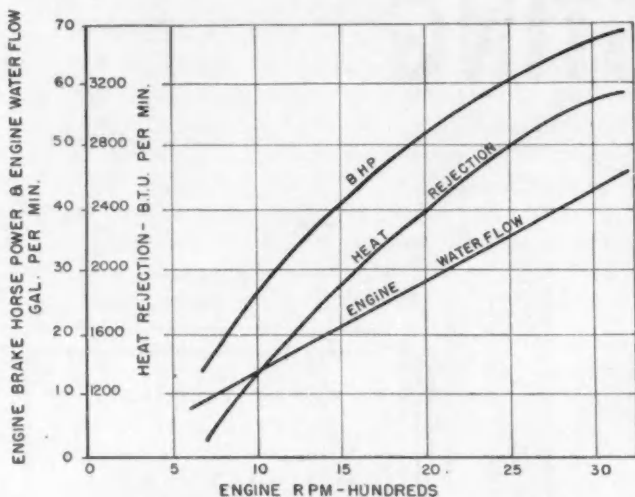


Fig. 3 - Heat rejection characteristics of an engine, determined in dynamometer tests, is important information in designing a radiator that will do a satisfactory heat-dissipation job

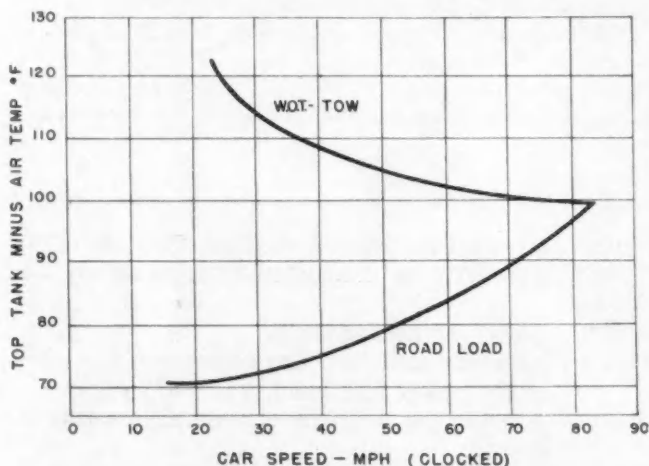


Fig. 4 - These curves represent the two cooling performance road test phases. Upper curve is for a wide open throttle (W.O.T.) load with the test vehicle towing another vehicle. The lower curve indicates performance for "road load conditions" - as when driving at a steady speed over level highway

the length of the water jackets; and whether or not the cylinders are of the siamese bore type) are determining factors in engine heat rejection.

In addition to the full load heat rejection, part load tests of engines reveal some interesting facts. For instance, tests have shown that, in general, heat rejection at no load was equal to 50% of the heat rejection measured under wide open throttle at the same speed. While this is a rather disconcerting result, it is nevertheless a true fact.

For practical purposes, it is estimated that an average of 12 Btu per min will be obtained for each cubic inch of engine displacement at 2000 rpm under wide open throttle.

Table 1 gives some heat rejection data obtained with various engines. Fig. 3 shows a typical heat rejection test curve.

Like any other components of a vehicle, the engine cooling system has, in addition to laboratory testing, to withstand severe road tests before its performance can be accurately evaluated.

When evaluating cooling performance, the cooling engineer must take into account all types of operating conditions and test the vehicles under a sufficient number of conditions so that a basis may be obtained for all types of driving conditions to be encountered in actual service. The greatest difficulty lies first in obtaining a satisfactory location to run the tests and, second, in running all the tests under constant conditions at the particular speed and load required.

Cooling performance tests in which the vehicle is in motion should be made preferably on a day on which there is no air motion other than that made by the vehicle itself. As can be imagined, this is a condition rarely encountered. In most cases, this difficulty is overcome by running the vehicle both with and against the wind and averaging the test data obtained on the two runs.

Road testing can be split into two types; namely, the type of testing that is done on the road with the vehicle in motion under actual driving conditions; and the type of test done with the vehicle stationary with the engine running at idling speed. While the latter type of test is done in an indoor laboratory, it is generally classified under "road testing."

The first type of cooling road testing, that is with the vehicle in motion, is usually divided into two phases. In one phase, the vehicle is driven at wide open throttle loads. This can be accomplished either by testing the vehicle on an incline or by towing another vehicle offering sufficient rolling resistance to put the required load on the towing car.

The towing type of test presents the advantage that it can be made on level ground, thus maintaining more constant conditions than those offered by the hill type of testing. A disadvantage of the towing type of test is that it requires an additional vehicle especially equipped so it can stand the extremely severe service to which it is subjected.

The other phase of cooling road testing with the vehicle in motion is commonly referred to as "road load conditions." These conditions are those encountered at a steady speed over a straight level road.

concluded on page 60

Table 1 - Heat Rejection Data for Various Engines

Engine Model	Displacement in cu in.	Heat Rejection in Btu per min at 2000 rpm Wide Open Throttle	Btu per cu in. of Displacement
A	173	2350	13.6
B	217	2920	13.5
C	218	2600	11.9
D	221	3450	15.6
E	248	2820	11.3
F	251	3050	12.1



BASED ON A PAPER\* BY

**R. Wayne Goodale**

Assistant Manager, Products Acceptance Department,  
Standard Oil Co. of California

**U**SING proper petroleum products largely has been responsible for successful starting of motor vehicle gasoline and diesel engines in sub-zero operations.

During the war, investigations were made of fuel and lubricant problems in diesel and gasoline-powered trucks, tractors, passenger cars, and aircraft in Canada, Alaska, and points along the Alaska highway, shown in the map above. Considering the following items, it was disclosed, insures easy starting:

1. Gasoline and diesel fuels,
2. Ice prevention,
3. Crankcase oils,
4. Starting fluid,
5. Greases.

The petroleum industry has provided gasolines with reasonably uniform performance regardless of season. But gasoline must meet conflicting requirements. It must be volatile enough to permit starting, but involatile enough to prevent vapor lock.

For this reason, gasolines at extremely low temperatures have performed well if auxiliary heat or starting aids were used to start the engine.

In diesel engines, high cloud and pour point fuels plugged screens, filters, and injection nozzles with wax that solidified. It was not uncommon for fuel flow to fail completely between the tank and

transfer pump of an engine. Auxiliary heat from torches, open fires, maintenance of heated storage, and even idling of equipment 16 hr for 8 hr use were used throughout the territory.

By the end of the war, diesel engines operated successfully on a No. 1 grade stove oil, provided starting aids were used at low temperatures.

Lower cetane number fuels generally have lower pour points. Although higher cetane number fuels can be used for starting at intermediate temperatures, the range in which this is important is limited, as shown in Fig. 1. It also shows that the time for starting diesel engines—even with higher cetane number fuels—is excessive at much below freezing.

For frigid operation, cetane number is secondary to adequately low cloud and pour points.

A common problem in both gasoline and diesel fuel systems is ice formation in the fuel. Fuels will dissolve from 30 to 50 parts per million of water at 70F, and less at lower temperatures.

Even though dry when leaving the refinery, the fuel frequently will pick up this amount of water in a short time, either from condensation or through contact with water in handling. On chilling, the water separates and forms ice. The ice often plugs fuel lines and filters and accumulates in diesel engine transfer pumps. Starting the engine shears off the pump safety pin.

An ice preventive developed to overcome this was distributed through frigid area for several winters. Using fractions of 1% of this preventive

\* Paper "Frigid Starting and Operation," was presented at SAE Annual Meeting, Detroit, on Jan. 9, 1947.

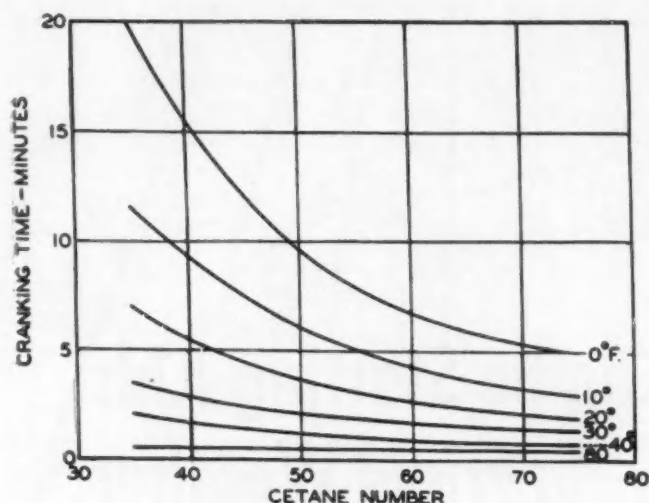


Fig. 1 - Using diesel fuels with high cetane numbers requires too long a starting period

effectively prevented freezing of previously dissolved water down to temperatures of  $-50$  to  $-60^{\circ}\text{F}$ . Fig. 2 shows the proportions required to lower the freezing point of entrained water to the desired temperature. The fluid is added to gasoline or diesel fuel in vehicle tanks when they are filled.

Crankcase lubricants are not without their problems. Viscosities of engine oils cannot safely be reduced because oils reach about the same equilibrium operating temperature, regardless of atmospheric temperatures. This stems from the fact that crankcase temperature is controlled largely by jacket temperature which, in turn, is held substantially constant by thermostats.

It introduced a major problem for thousands of diesel and gasoline units operated at remote northern locations. Since this equipment was stored outside, oils of required viscosity were either too viscous to permit cranking, or the pour

point was too high to permit fluid flow at starting temperatures.

This led many operators to resort to some of these practices for temperatures ranging from  $0^{\circ}\text{F}$  to  $-60^{\circ}\text{F}$ :

1. Idling engines continuously when not in use;
2. Draining oil when the engine was shut down and heating and replacing it in the crankcase in the morning;
3. Heating crankcases with a fire pot or an open fire built under the crankcase. (Many units were destroyed by fire through this procedure.)
4. Covering units with large tarpaulins and placing heaters underneath during the shut-down period. (This was time-consuming and required portable equipment.)
5. Diluting crankcase oil with various light oils or kerosene. (This did not work too well since the oil viscosity was too low when the engine reached operating temperatures.)

Ground operators later took a cue from the Air Force - which had solved the problem using gasoline for diluting engine oil - with good success. Advantage of a temporary over a permanent diluent is that a lesser amount is required to reduce viscosity and pour point to desired values. Gasoline will evaporate after starting so that the engine will operate on the original grade of lubricant after it is warmed. Also, gasoline is readily available and the type used is not critical.

Fig. 3 shows the amount of gasoline required to reduce sufficiently the viscosity of automotive grade oils for satisfactory starting. Procedure to insure easy starting after the engine has cooled, experience showed, consists of pouring the gasoline into the crankcase through the oil fill pipe. This is done just before shutting down the engine. The engine then is idled for 10 to 15 min to mix the oil and fuel.

Engine winterizing up to this point included selection of the proper fuel, dilution of crankcase

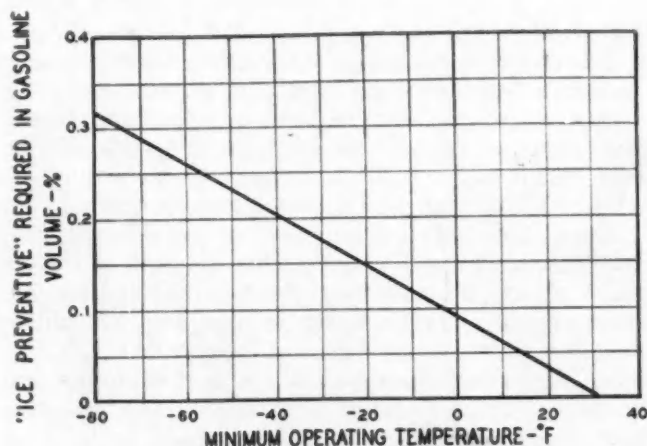


Fig. 2 - This chart gives the percentage by volume of ice preventive needed to prevent water in gasoline from freezing at various operating temperatures

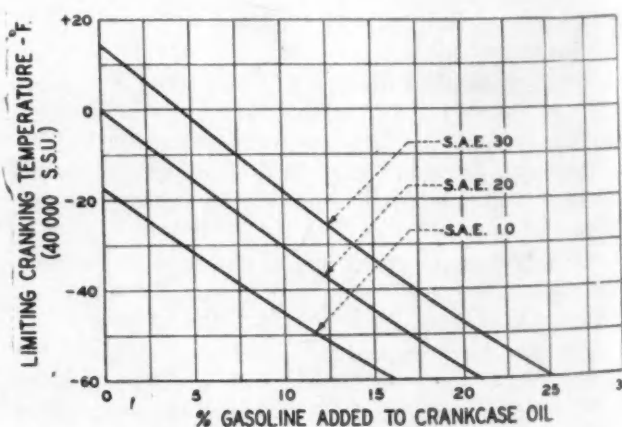


Fig. 3 - Diluting engine oil with gasoline in the amounts shown will reduce oil viscosity sufficiently to permit satisfactory starting under frigid conditions

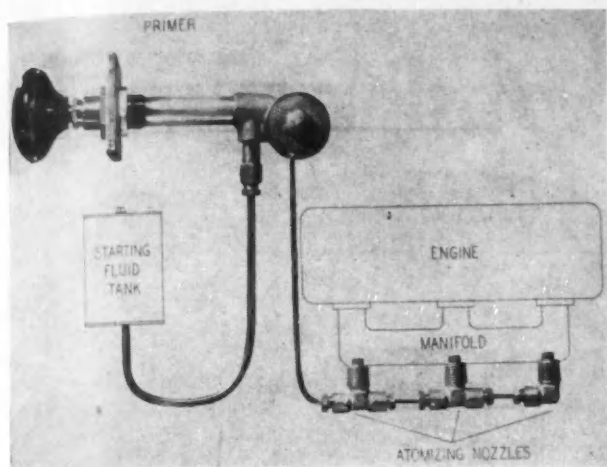


Fig. 4—Atomizing and injecting the starting fluid into the intake manifold with this primer system allows engines—especially automotive diesels—to start at extremely low temperatures

oil, and addition of ice preventive to the fuel. But despite these measures, starting diesel equipment below 30F and gasoline engines below 0F may be difficult.

A starting fluid developed permits easy starting of automotive-type diesel engines at much lower temperatures than were possible with conventional fuels plus oil dilution and ice preventive.

For example, attempts to start an engine at -50F without the starting fluid failed. With this starting aid, an automotive diesel started in 10 sec. No difficulty was experienced in starting aircraft and automotive gasoline engines at temperatures as low as -40F using starting fluid.

This material is injected into the intake manifold during starting operation by atomizing with a primer system shown in Fig. 4. By introducing the fluid through the air cleaner, other application methods such as a continuous spray, fly spray gun, or air pressure atomizer can be used with varying degrees of success.

At subzero temperatures, the fluid must be supplied for a period up to 30 sec to maintain combustion—until the combustion chamber is sufficiently warmed to burn diesel fuel.

#### Fluid Readily Ignited

A flammability range seven times greater than pure hydrocarbons is one of the fluid's major advantages. The material is very unstable under diesel engine temperatures, self-ignition occurring at unusually low temperatures. Even under extreme cold, 1½ to 2 oz of the fluid was found sufficient for a start. Diesel equipment operators in the north country estimated that this fluid saved from 1½ to 2 hr per start compared with heat application or continuous engine cranking.

It should be mentioned that even with diluted crankcase oil and starting fluid, the battery of an electrically-started engine must be warm enough

to crank the engine. (A storage battery's output decreases materially at subzero temperatures.) A booster battery can be used where it is not possible to warm the service battery.

If the engine can be started, the fuel and lubricant problems generally are minor. But proper grades of gear lubricants should be used for best results.

Major gear lubricant problem is selection of the correct viscosity or SAE grade for the conditions involved. A newly developed product that performed well is an extreme-pressure gear lubricant of light viscosity, known as grade 75.

Most serious trouble with improper gear lubricants—too high channel points—is the possibility of gear failure because of inadequate lubrication before the gear case warms up. Grade 75 was successful at subzero temperatures up to a maximum of 32F.

Problems with wheel bearing and chassis greases early in the war were similar to those of gear lubricants.

In addition to specialized petroleum products for frigid starting, excellent heaters were developed. Best method of operating equipment in frigid areas may be winterized fuels and lubricants, auxiliary heat, or a combination of the two. But regardless of mechanical aids, use of cold-weather petroleum products minimized winter troubles by permitting successful starting and operation of equipment under extreme conditions.

## BUS SHELL DESIGN

cont. from p. 41

later on subsequent smoother roads. This assumes that stress is proportional to roughness. It has been demonstrated that overstressing immediately followed by normal stressing decreases life at the normal stress. However, if overstressing is followed by understressing, life at normal stress is not shortened.

There are a few portions of the body shell where stresses are so low that neither yield nor fatigue strength determine design. Panels remote from windows and doors are one example. Theoretically, it is desirable to minimize weight by using parts just adequate to equalize stress. Actually, it is not economical to equalize panel stress by using several thinner gages for understressed panels or by adding stiffeners to other panels. The gage used may be selected by some consideration such as the thickness needed for ease of handling in the shop.

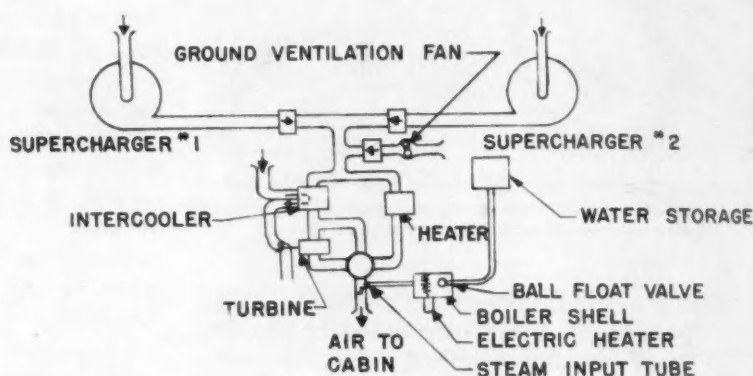
Stability generally governs the design when strength is secondary. Then the efficiency of a material is roughly proportional to the elastic modulus divided by the cube of the density.

# Air Conditioning of Pressurized

Exhaustive study of air conditioning requirements for large, pressurized transports of the DC-6 variety under all atmospheric conditions up to 30,000 ft has led to the design of the basic air conditioning system shown here.

This system includes such vital features as dual superchargers to provide 20 cfm of fresh air per passenger, a turbine and intercooler circuit to provide refrigeration on the ground and in flight, and a ground ventilation fan for use when engines are not running.

The simple steam humidifier, although not considered essential by Mr. Del Mar, can give humidity comfort in extreme winter weather or at very high altitudes. It uses



only 30 lb of water on a 5-hr flight and has negligible weight when not in use, as under summer conditions.

In the accompanying article Mr. Del Mar discusses the background for this system in terms of air freshness, temperature, and humidity requirements.

**N**O mode of passenger travel encounters such tremendous variations in ambient air conditions over short periods of time as does the airplane. To assure uninterrupted passenger comfort throughout these conditions on the ground and in flight requires versatile and high-capacity air conditioning equipment.

This study was undertaken to furnish facts and figures on which to judge and design the air conditioning system. It was especially desired to create a basis for air freshness determination, to evaluate the controversial subject of recirculation, and to predict the humidity conditions to be encountered in typical pressurized cabin operation. Cabin pressure comfort requirements were purposely excluded.

This analysis has led to the following conclusions:

1. Cabin fresh air rates that approximate 20 cfm per passenger furnish a suitable compromise to the many problems involved, and apparently maintain luxury conditions for the cabin.

2. The comfortable range of cabin humidity is closely dependent on the control of cabin temperature in a relatively narrow comfort range, and if cabin temperature control, heating, cooling, and temperature distribution are given special emphasis, the need for close control of humidity is minimized.

3. Cabin air is very dry during heavy heating from low ambient temperatures, but is not critically influenced by other variables. When desired this dryness can be suitably alleviated by fresh water humidification.

4. Low cabin humidity during flight in extremely cold outside air is desirable to a degree to avoid window fogging or frosting.

5. Air in a plane the size and type of the DC-6 is humidified an average of 8% in passing through the cabin, and the final humidity can be increased another 8% by adding 5½ lb of water per hr to the incoming cabin and pilots' compartment air.

6. Pilots' compartment air can be expected to be about 4% drier than cabin air, which may be ad-

# Aircraft Cabins

EXCERPTS FROM A PAPER\* BY

**Bruce E. Del Mar**

Mechanical Test Engineer, Douglas Aircraft Co., Inc.

vantageous from the standpoint of frosting of unheated window surfaces.

7. Peak air humidities encountered on the ground or in flight drop off rapidly with a chosen increase in dry bulb temperature - which considerably improves the temperature and humidity results on cabin air in hot weather.

8. A temperature reheat cycle is imposed on refrigerated air passing through the cabin by being subjected to heat transfer from surrounding air, cabin equipment, and passenger sensible heat loads. This reheating helps maintain the resultant maximum cabin humidity within comfortable limits in warm weather.

9. A recirculation air system for the DC-6 would improve humidity conditions during heating but would make humidity and refrigeration conditions worse during cooling, would introduce a serious smoke problem, and would detract from the reliability, cleanliness, and ease of maintenance of equipment and cabin sealed structure.

10. A cabin air system consisting of two variable-speed centrifugal superchargers delivering a total of about 20 cfm of air per person to the cabin through a selective heating, intercooling, or refrigeration cycle with a separate ground ventilation and heating fan, and a separate fresh water humidification equipment is deemed suitable for air comfortization of a transport plane designed for speeds and altitudes associated with immediate postwar luxury travel such as the DC-6.

**Fresh Air Rate** - The foremost requirement of the amount of fresh air that must be used in ventilation is that determined by odor freshness. A method of evaluating fresh air requirements for passenger vehicles is introduced, which consists of applying a passenger loading or seat utilization factor to data obtained from sensory ventilation tests. The basic sensory data are obtained from

\* "Analysis of Transport Aircraft Cabin Air Conditioning Requirements with Special Reference to Air Freshness, Temperature, and Humidity Control" was presented at the SAE National Aeronautic Meeting, Los Angeles, Oct. 3, 1946.

Harvard University tests, and special interpretation of intensity scales is based on ventilation tests performed under controlled temperature and humidity conditions with persons in a full-scale cabin test section.

The following conditions are stipulated:

1. Freshness of air rather than staleness must be evident.
2. A predominance of adult male passengers.
3. The socio-economic status of passengers is high.
4. Outside air is entirely fresh.
5. A well-diffused sectional distribution of cabin air exists that prevents channeling or seat-to-seat accumulation of odors.

Fig. 1 shows (in solid lines) the odor intensities that may be expected at various fresh air rates as a function of percentage of seat utilization.

Table 1 is an evaluation of the odor intensity scale. Column 1 is based on Harvard University tests and Column 2 is based on full-scale controlled temperature room tests with 16 to 19 persons at a time in a DC-6 cabin section complete with actual interior appointments.

For 100% seat utilization, Fig. 1 shows, for example, that a fresh air rate of 18 cfm is recommended to achieve an odor intensity of 2.5 found suitable in Douglas full-scale cabin section tests with passengers in simulated flight.

A second consideration in the determination of required cabin fresh air rate is that dictated by pressure cabin leakage. Since hermetic sealing is impractical, a reasonable incoming air supply must be provided to allow for leakage, thus permitting satisfactory air distribution and cabin pressure control even after leakage has accumulated from many hours of flight. A cfm value at least one-twentieth the cubic foot volume of the cabin is at present applicable. For the DC-6 this flow is about one-fourth the incoming fresh air necessary for odor freshness, but becomes an influencing factor when considering any large degree of reclamation and recirculation of air with reduced outside air rates.

**Temperature Comfort** - The Association of American Railroads has indicated the dry bulb temperature relations given in Table 2 as desirable for summer comfort.

For summer comfort with extreme outside air temperatures of 104-109 F (that is, 45-50 F above NACA standard), it is obvious that a cabin temperature of 80 F is indicated as most desirable.

Temperature comfort conditions are also influenced by the effect of radiation heat transfer between passengers and cold side panels and windows. Panel heating, window insulation, and warm air diffusion must be planned so as to assure temperature comfort conditions.

**Humidity Comfort** - Average ideal comfort combinations are:

	Desired Effective Temperature, F	Relative Humidity, %	Dry Bulb Temperature, F
Winter Conditioning	60	70 30	68 72
Summer Conditioning	71	70 30	74 78

Humidity comfort is thus seen to be allied closely with dry bulb temperature.

If the temperature is either abnormally low or high, it is important that humidity be kept within reasonable limits, the lower the better. If dry bulb temperature is controlled correctly, however,

Table I—Sensory Intensity Scale of Body Odor

Odor Intensity Index		Characteristic Term	Qualification (Reaction upon Entering)
Harvard <sup>a</sup>	Douglas <sup>b</sup>		
0	0	None	No perceptible odor
1/2	1	Threshold	Very faint, barely detectable by trained judges, usually imperceptible to untrained persons
1	1 1/2	Definite	Detectable by all normal persons but not in the least objectionable
	2		Readily detectable but not unpleasant
2	2 1/2	Moderate	Neither pleasant nor disagreeable. Little or no objection. Allowable limit in rooms (herein recommended as design limit in aircraft, see Column 2)
	3		Objectionable only on first entering
3	3 1/2	Strong	Objectionable. Air regarded with disfavor
4		Very strong	Forceable, disagreeable
5		Overpowering	Nauseating

<sup>a</sup> Room ventilation tests.

<sup>b</sup> Controlled temperature room tests with ventilation of an actual cabin section.

extremes of relative humidity are apt to cause very little discomfort and relative humidities of 15-85% may go completely unnoticed.

To prevent condensation of moisture on windows and other interior cabin surfaces, relative humidity must be maintained at reasonably low values during extremely low outside temperatures.

**Other Basic Requirements**—At the present stage, it is highly important to operate continuously two individual sources of fresh air to assure uninterrupted maintenance of ventilation and cabin pressure in case of engine failure.

Adequate cabin ventilation must be maintained on the ground at engine speeds as low as it is possible to idle. For ventilation with engines stopped, an electrically driven ground blower must be provided to deliver sufficient air through the cabin heater to assure reasonable maintenance of temperature and air quality.

Standard ventilation practices call for air velocity over the individual of 25-50 fpm, depending on the temperature of the circulated air (25-30 fpm for heated air and 40-50 fpm for cooling air). These practices are applicable to the aircraft cabin, but are influenced considerably by the flexibility of use of individual cold air outlets.

**Ventilation with 100% Fresh Air**—Plotted as dashed lines in Fig. 1 are typical cfm values of fresh air per person for various percentages of

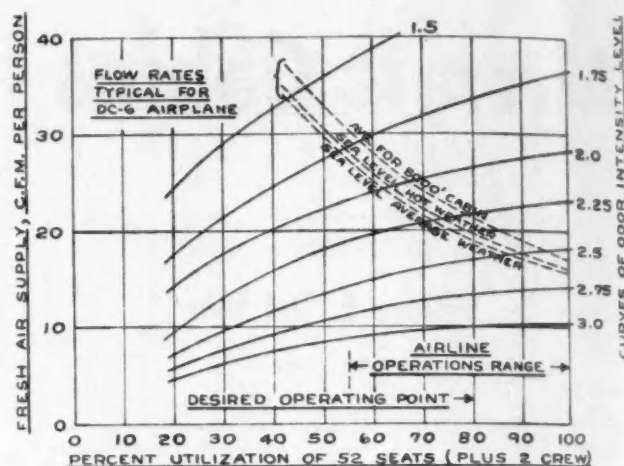


Fig. 1—Variation of fresh air rate and air freshness index as function of DC-6 passenger loading

seat utilization. These values average 20 cfm per person or better. This figure also shows the associated odor intensities in the cabin. For the normal range of seat utilization (55-100%), the index of air freshness centers close to 2.0. For operation at 80% utilization, the index is 2.35.

**Air Conservation, Reclamation, and Recirculation**—Advantages claimed for having a low rate of fresh air to be pumped into the pressure cabin include: weight and cost savings on supercharger equipment, power savings on the engines, and space advantages associated with small superchargers. If means are provided partially to reclaim air used for ventilation in the cabin, then the quantity of outside air to be pumped can be reduced while still maintaining freshness in the cabin and certain of these advantages can possibly be attained. Recirculation of air is generally necessary to accomplish reclamation, so conservation, reclamation, and recirculation are necessarily the same.

Full reclamation of air theoretically involves: addition of oxygen used in breathing; removal of carbon dioxide created in breathing; removal of body, tobacco, and perfume odors; removal of visible smoke haze; and removal of excess moisture.

For the average passenger liner the ventilation rates required for structural leakage and control are sufficient to maintain adequate concentrations of oxygen and carbon dioxide. In the event of dual supercharger failure, ram air ventilates the cabin.

Some experience has been obtained by the air

Table II—Dry Bulb Temperature Relations for Summer Comfort

Outside Temperature, F	Desired Inside Temperature, F <sup>a</sup>
80	74
90	76
100	78

<sup>a</sup> Variation of temperature from inside average at any point not to exceed 2 F; air at ankle level to be within 1 F of temperature at head level of a person seated.

conditioning industry with the use of activated charcoal, silica gel, and ozone for the removal of odors from cabin air.

Ozone reduces the smell of odors by masking the mucous membranes of the nasal passages, but the correct concentration is difficult to control and the gas becomes toxic at higher concentrations.

For the use of silica gel or carbon, air must be passed over them, and thus recirculation of the air is expected. Silica gel, a combination drying agent and deodorizer, is cleaner than carbon, but rapidly loses its activity in damp air. Carbon absorbs less water and has a relatively long life. A special, high efficiency and light weight carbon filter has been considered for the DC-6. It consists of 111, 1/16 diameter, perforated metal tubes filled with 10.3 lb carbon and arranged in six banks in a filter assembly 16 in. long, 14 in. wide, and 4 in. thick. Efficiency is 85% and rated flow 550 cfm. It weighs 20 lb.

Smoke removal must be accomplished electrostatically, since the particle sizes are extremely minute. Railroad air conditioning practice has indicated that with outside fresh air rates of 15 cfm per passenger, smoke concentration is not bothersome even without special means of eliminating it.

Even with the minimum airflow rates dictated by conditions already noted, the relative humidity increase in recirculated air is always less than 15%, which is less than the humidity variation encountered in the atmosphere.

The actual power saving can be estimated as follows: Assuming the average overall flight altitude to be 15,000 ft and full differential pressure, the average supercharger shaft power is 16½ hp for a fresh air rate of 10 cfm per passenger, and

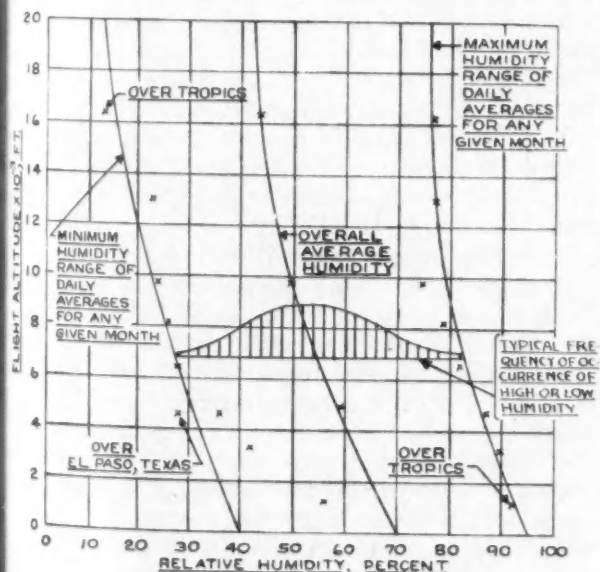


Fig. 2 - Humidity in upper air (from Weather Bureau data)

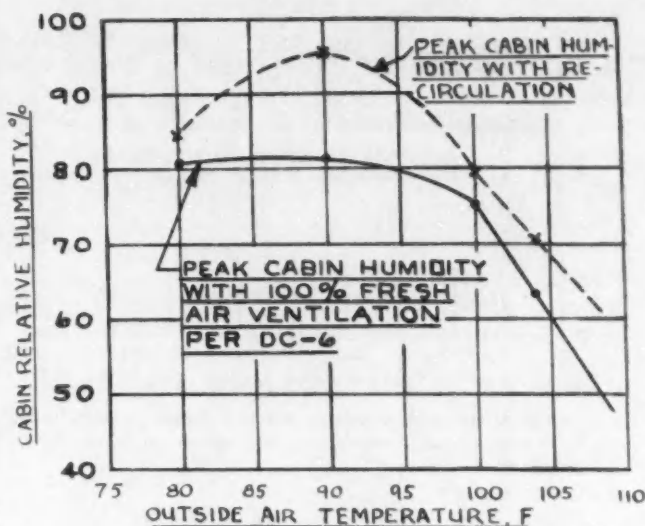


Fig. 3 - Peak cabin humidity with peak outside humidity during full refrigeration at ground level

the drive may be operating at an average mechanical efficiency of 90%. Thus if the outside fresh air rate is reduced from 20 to 15 cfm per passenger, the average power saving is 9.15 hp, and if it could be reduced from 20 down to 10, it would be 18.3 hp. The power required to operate a recirculating fan must be deducted from this.

**Cabin Air Temperature Conditioning** - A mild form of air cycle refrigeration is reasonable and adaptable to the DC-6. Air drawn in from outside is compressed, cooled under pressure, and expanded semiadiabatically through a turbine to a temperature below that of the ambient atmosphere. The cabin supercharging blowers may be made to furnish such a compression source, since peak refrigeration loads and peak cabin pressure loads occur at different extremes of altitude range. Refrigeration is never needed above 15,000 ft and the refrigeration capacity tapers from zero at this altitude to maximum at sea level. Intercooling may, however, be used above 15,000 ft.

Determination of the required refrigeration capacity must be a compromise procedure. About 700-1000 Btu per hr per passenger seat is reasonable, provided the cabin is well insulated and cabin superchargers are thermally efficient and variable speed. This capacity must be arranged to suit reasonable limits of speed, compression ratio, torque, and power on the cabin superchargers and their drive.

The rate of fresh air chosen may have a considerable effect on refrigeration capacity. Assuming compression limits are to be maintained, refrigeration capacity is cut in half by a reduction of air rate from 20 to 10 cfm per passenger, while the heat rejection requirements remain nearly the

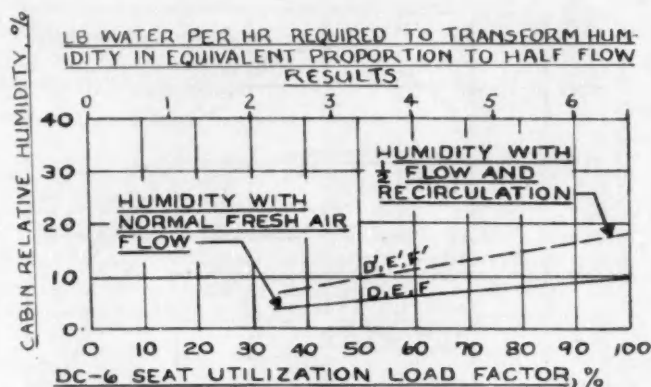


Fig. 4 - Effect of reduction of fresh air to one-half flow on cabin humidity (with recirculation) - curves at -40 F outside air temperature  
D - 20,000 ft  
E - 15,000 ft  
F - Sea level

same. If heater compression of the air were planned to counteract for this flow reduction while maintaining the same refrigeration capacity, an increase in supercharger pressure rise of 23% would be required.

**Cabin Air Humidity Conditions** - Relative humidity of entering cabin air may be calculated approximately by:

$$\phi_c = \frac{161p_c}{S_z} \left[ \frac{0.00622\phi_f S_f}{P_f} + \frac{0.0167M}{W_f} + \frac{0.0167mN}{W_f} \left( \frac{W_r}{W_f - W_r} \right) \right]$$

where:

$p_f$  = Absolute pressure of flight atmosphere, in. of hg

$p_c$  = Absolute pressure of cabin atmosphere, in. of hg

$N$  = Number of passengers and crew in cabin

$W_f$  = Weight flow of outside air, lb per min

$W_r$  = Weight flow of recirculated air, lb per min

$M$  = Weight of reservoir water added mechanically to cabin air, lb per hr

$m$  = Weight of water vapor added per passenger at cabin air temperature, lb per hr

$\phi_f$  = Relative humidity of outside air, %

$S_f$  = Pressure of saturated vapor at temperature of atmosphere at flight level, in. of hg

$S_z$  = Pressure of saturated vapor at temperature of cabin air, in. of hg

Relative humidity of cabin exit air has been accepted as the most representative measure of cabin humidity conditions felt by the occupants, and may be calculated by the approximate formula:

$$\phi_z = \frac{161p_c}{S_z} \left[ \frac{0.00622\phi_f S_f}{P_f} + \frac{0.0167M}{W_f} + \frac{0.0167mN}{W_f} \right]$$

The weight flow of water per hour that must be added or removed from the air to achieve a given cabin exit air humidity may be calculated approximately by the formula:

$$M = 60W_f \left[ \frac{0.00622\phi_z S_z}{P_c} - \frac{0.0167mN}{W_f} - \frac{0.00622\phi_f S_f}{P_f} \right]$$

or the exact equation:

$$M = 60W_f \left[ \frac{0.622}{\frac{100p_c}{\phi_z S_z} - 1} - \frac{0.0167mN}{W_f} - \frac{0.622}{\frac{100p_f}{\phi_f S_f} - 1} \right]$$

The latter equation should be used for moisture removal calculations; the former is sufficiently accurate for moisture addition calculations. A minus answer indicates moisture removal.

Weather data on average humidities are shown in Fig. 2. Humidities anywhere between the maximum and minimum shown can be expected to be encountered regularly with transports such as the DC-6 and humidities outside this range can be expected occasionally. Fig. 2 also shows a frequency of occurrence representation of humidity from analysis of basic data.

In analyzing the humidity conditions to be expected, it is desirable to work out a number of problems, assuming different flight altitude and cabin altitude combinations, while varying from winter to summer temperatures and minimum to maximum humidities at these altitudes. Such data will usually show that the humidity value chosen for the outside air has little effect on final cabin humidity during extreme heating conditions.

**Cabin Humidity during Cooling** - Next, cabin humidity conditions during cooling should be investigated. Since an increase in cabin humidity can be expected only if the outside air is above the desired cabin temperature, investigation of humidity during cooling need only be considered at altitudes below 10,000 ft. Actually the refrigeration capacity should be maximum at sea level, so that the humidity studies can, for all real significance, be made at sea-level conditions. The maximum refrigeration capacity may produce a midcycle air temperature drop to a value 30-50 F below outside air temperature. Cabin temperature will always stabilize at a value higher than the refrigeration turbine discharge temperature by an amount varying from 5-15 F, depending on the cabin heat loads and insulation. Thus, a reheat cycle actually occurs. This reheat cycle tends to decrease humidity of cabin air even though full saturation is reached at the turbine discharge. If the dew point is reached before completing the refrigeration cycle, however, part of the refrigeration capacity is used in the condensation process and a higher cabin temperature will result.

Further analysis next should be made of cabin air humidity resulting from operating during refrigeration conditions with extremely humid outside air during extremely warm weather, and again

for extremely humid outside air during mildly warm weather. Data developed by such analysis on the DC-6 shows that:

1. Cabin air relative humidity can generally be maintained below 85% even with the most extreme outside temperature and humidity combinations.

2. Cabin humidity, as well as temperature, will be lower in the cabin than outside during the extreme humidity conditions that can occur with outside air at 75-85 F.

3. Cabin air humidity below 70% can always be expected for the most extreme outside temperatures of 100 F or more.

The peak cabin humidities that may be expected to occur in extremely humid weather in the DC-6 are shown by the lower curve in Fig. 3. These results are well within the comfort limits specified for the cabin.

**Effect of Air Conservation and Recirculation on Humidity**—The typical effect of air conservation and recirculation on humidity during heating is shown by Fig. 4 for -40 F outside temperature. It was assumed that one-half the normal fresh air rate was used and one-half the normal flow was recirculated. The moisture values, in pounds of water necessary to be added to 100% fresh incoming air to accomplish the same desirable effect on cabin humidity as is effected by recirculation, are shown in Fig. 4, together with the seat utilization factor. Note that for the average case of 80% seat utilization, 5 lb or  $\frac{5}{8}$  gph of fresh water added to the incoming cabin air would accomplish the same improvement in cabin humidity.

The effect of air conservation and recirculation on humidity during refrigeration is shown in Fig. 3. Recirculation is detrimental to the maintenance of lesser humidities during refrigeration in humid weather. With the most humid weather ever to be expected, the cabin humidity remains below an extreme of 84% when operating on the rated DC-6 100%-fresh air system, whereas with recirculation it could climb to 95.3%!

**Humidification with Fresh Water**—The addition of moisture during extreme heating conditions appears attractive, although its absolute necessity to assure comfort may best be determined by trial in service. With a reasonable quantity of fresh water, the dry conditions in the cabin can be improved to remain always above 15% even with extreme heating at normal seat utilization factors.

Water flow rates of 5 and 10 lb per hr produce the cabin humidities shown in Fig. 5. Higher cabin humidities may prove undesirable during extremely low outside temperature conditions due to the frosting of windows. Any large degree of recirculation with a reduced fresh air rate cannot advantageously be adopted for this purpose, as it may prove detrimental in maintaining cooling capacity, keeping the cabin clear of smoke, and

holding cabin pressure. Water may be vaporized into the incoming air stream by a number of methods.

Water pressure spray injection introduces difficulties, since solid injection spraying usually does not produce sufficient atomization to prevent condensation on duct surfaces.

Air-water spray atomization, as accomplished with an aspirating type of water atomization nozzle, will usually prove entirely satisfactory. It requires a weight flow of air approximately equivalent to the water flow. For example, atomization of 6 lb of water per hr requires 4-5 lb of air per hr discharged from a pressure of 20-30 psi with respect to the cabin. This air must be clean and free from oil contamination so that a reciprocating diaphragm type of compressor, or equivalent, is essential.

Boiling point vaporization to steam can be accomplished readily by means of the system heater or by one or more electrical immersion heaters. The use of the electrical boiler is attractive since fluid metering is simply and readily accomplished merely by controlling electrical energy input. Thus a controllable rate of water input, obviously desirable, can easily be provided.

If water vapor is to be added to the incoming air stream, it must of necessity be placed into the cabin air downstream of the cabin heater. Spray atomization produces evaporative cooling on the incoming air, so that in order to maintain a given dry bulb temperature of this air, heat must be added by the incoming air heater. Boil-

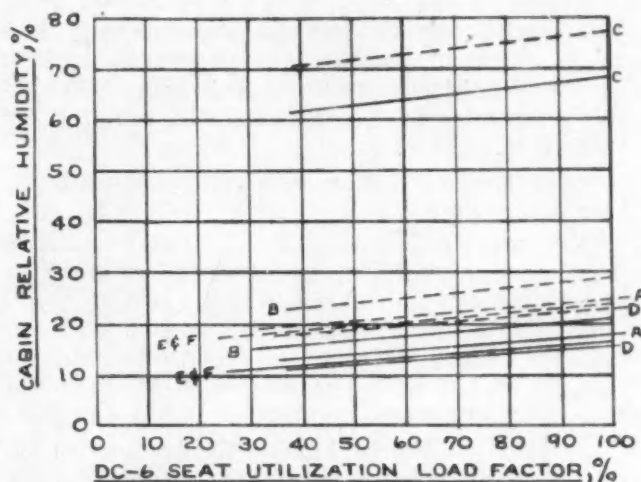


Fig. 5—Cabin humidities after fresh water humidification—solid curves for water rate of 5 lb per hr; dashed curves for water rate of 10 lb per hr

- A - 20,000 ft and standard temperature
- B - 15,000 ft and standard temperature
- C - Sea level and standard temperature
- D - 20,000 ft and -40 F
- E - 15,000 ft and -40 F
- F - Sea level and -40 F

ing of steam into the air produces a steam temperature in excess of the incoming air temperature, so that the air heater load is reduced slightly.

**Pilots' Compartment Humidity Conditions** — During heating the humidity in the pilots' compartment may be expected to average 4-5% less than in the passenger cabin. The incoming air humidity is the same but the relatively low occupancy per unit volume means that the air the pilots breathe never attains as high a relative humidity as that in the cabin. This may also be shown to be true during refrigeration. If ventilation air were to be recirculated, the lower humidity of pilots' compartment discharge air makes this air more unsuitable to recirculate to gain in humidity during heating, but this air is more desirable as a recirculation source during extreme cooling. This effect on cabin air conditions must be evaluated whenever recirculation is being considered.

## NEW ELECTRIC RETARDER

cont. from p. 47

Equipped with eddy current retarders, this same vehicle can be driven safely down the 10% grade 100 miles in length at 40 mph — if the road could be traveled over safely at this speed were it level. The loads on brakes, engine, and transmission would not be excessive. And it follows that these units would require less maintenance and last longer. Incidentally, the rate of heat dissipation required for this energy build-up is about 360 hp — nearly three times the capacity of a radiator for a 450-cu in. engine.

On-the-road experience with retarders bears out these conclusions.

Many tests were made with a dissipator-equipped tractor trailer (45,750 lb gross vehicle weight) on the east slope of Laurel Ridge near Ligonier, Pa. — a grade of about 9% and some four miles long. With the dissipator in action, speed was held between 30 and 40 mph — varying with grade steepness — without a single application of wheel brakes.

Inspection of the brakes on the tractor-trailer unit after 2500 miles of service showed the linings were not yet well seated and the grinder marks on the drum were still plainly visible. It is difficult to estimate accurately lining life using the retarder; but 200,000 miles is a conservative guess. Engine and transmission maintenance also will be saved, although an accurate estimate is not possible.

How much can be gained in schedule speed is

not easy to determine since present schedules involve so much risk in running out grades to save brake and engine maintenance. But the feeling of security in driving a heavy vehicle equipped with an energy dissipator cannot be evaluated in figures or expressed in words. It must be experienced.

With energy dissipators auxiliary to wheel brakes to permit safe cruising speeds down grade, time between terminals really can be reduced. Instead of more tons-per-vehicle-per-trip and fewer trips-per-year, why not the same tons-per-vehicle-per-trip but more trips-per-year?

## CAR COOLING SYSTEMS

cont. from p. 50

The other type of cooling road-testing performed, with the vehicle stationary and with the engine at idling speed, is considered as part of the road testing work although it is conducted indoors in some closed space where a steady temperature of 70 to 80 F is maintained.

The two types of testing described above, either at wide open throttle or under bad road conditions, determine — as in the idle test — cooling performance under various conditions with respect to the particular air temperature at which the vehicle is operating.

The data normally taken comprise the surrounding air temperature,  $t_1$ ; the radiator inlet coolant temperature,  $\theta_1$ ; the radiator outlet temperature,  $\theta_2$ ; and the vehicle load and speed. Assuming the surrounding air temperature to be 100 F, let us further assume that tests were run which would give an entering water temperature to the radiator of 180 F.

The cooling performance of the vehicle can now be determined by simple arithmetic as this performance is equal to the difference between  $\theta_1$  and  $t_1$ . In the example just given, the cooling performance would consequently be:

$$\theta_1 - t_1 = 180 \text{ F} - 100 \text{ F} = 80 \text{ F}.$$

Fig. 4 shows a typical road test curve. This curve indicates that the wide open throttle performance and the road load performance are equal at the maximum speed of the vehicle. Some models have cooling performance curves of slightly varying slopes due to grilles and fan combinations used. However, this curve is quite typical for the average competitive model of today. It is considered that a very good cooling performance for a modern 6-cyl car would be:

- 100 F at 30 mph at W.O.T.
- 75 F at 60 mph at road load conditions, and
- 110 F at 500 engine rpm — idle.

# Improved Piston Ring Designs Curb Premature Failure

EXCERPTS FROM A PAPER\* BY

**Helmuth G. Braendel**, CHIEF ENGINEER, WILKENING MFG. CO.

EVER higher demands on diesel engine piston rings are being met by recent ring design developments, some of which derive from wartime research for high output aircraft engines.

Prior to the war, practically all of the compression rings were of the plain type. These rings have a rectangular cross section with parallel sides. They performed satisfactorily in relatively low output engines, but permitted scuffing and excessive blowby to occur whenever an engine was subjected to higher loadings. In the high output aircraft engines, this type of ring failed in an extremely short time.

It was found that when a twist was imparted to the ring, its performance in regard to blowby control and life was improved considerably. This twist was produced by removing metal either at the upper corner of the inside diameter, or at the lower corner of the outside diameter.

This unbalance in the section will cause the ring to twist when it is compressed to cylinder size in such a way that it contacts the upper piston land close to the O.D., and the lower piston land close to the I.D. The ring also contacts the cylinder bore at the lower edge. Line contact at a high unit pressure produces a much better seal against the passage of gases around the back of the ring.

The initial line contact at the lower edge of the face also produces a better seal between the ring and the cylinder. In addition, it allows the ring

\*Paper "Late Trends in Piston Rings with Special Application to Diesel Engines," was presented at SAE Metropolitan Section, New York, Feb. 6, 1947.

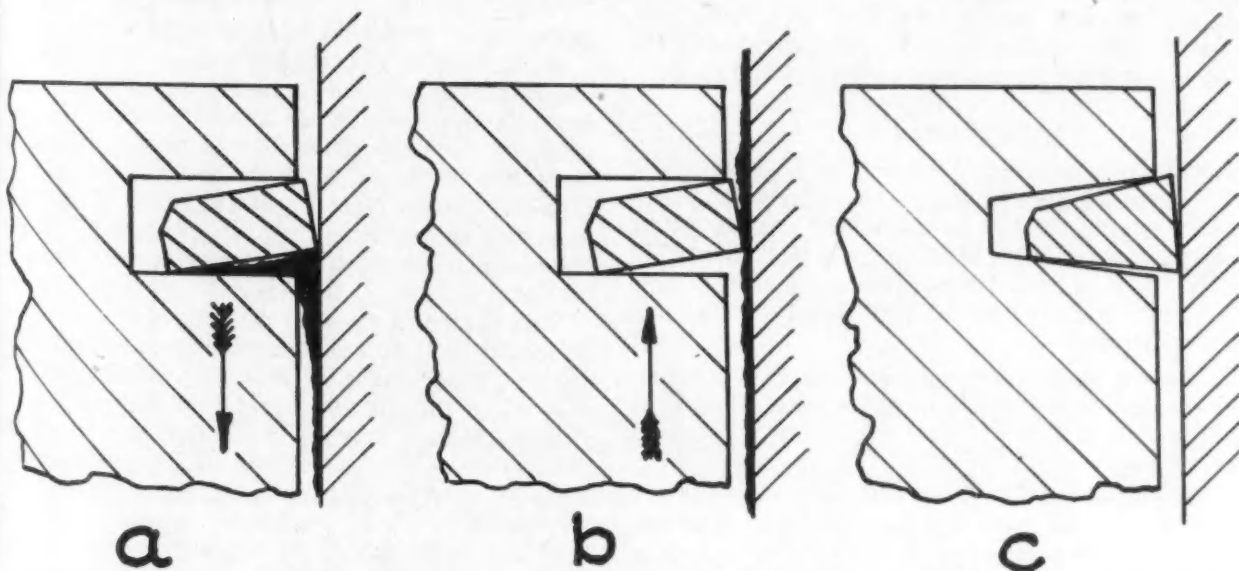


Fig. 1 - On the down stroke (a), the twisted type compression ring removes all excess oil from the cylinder wall without allowing any to pass around the back of the ring. By sliding over the oil film on the up stroke (b), the twisted ring preserves adequate lubrication. The wedge-shaped ring (c), which also can be twisted, alleviates ring sticking despite carbon and sludge accumulations

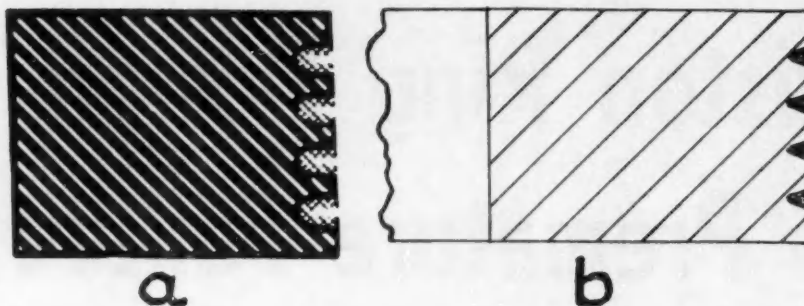


Fig. 2—Grooves of the ring in (a) are coated, not filled, with tin which melts and serves as a lubricant during critical operation. Grooves around the face of the ring in (b) are filled with a porous carbonaceous material that retains oil for emergency lubrication, particularly during run-in

to seat or wear-in quickly and produces a certain amount of oil control action during the seating period, as shown in Figs. 1a and 1b. Twisted rings, therefore, are replacing plain type rings in most automotive installations and are starting to be used in the smaller high-speed 4-cycle diesels.

In some installations ring sticking is a serious problem. It occurs mainly under conditions of high temperatures and high pressures which are experienced both in aircraft and diesel engines. In such installations, a wedge type ring, shown in Fig. 1c, has been found to eliminate sticking when all other means such as increasing the side clearance have failed.

This ring prevents sticking mainly because ring wear on the face of the ring will produce increased side clearance in the groove, constantly compensating for the accumulation of carbon and lacquer which is the primary cause of ring sticking.

These rings are now used as standard equipment, on Cummins diesel engines, and in some models of Waukesha. Although most manufacturers still use a plain wedged ring, one without twist, this ring will also perform better in regard to blowby control if bevelled at the upper I.D. and twisted in the same manner as the parallel-sided twisted rings.

#### Special Purpose Rings

A relatively recent development made specifically for 2-cycle diesel engines is the filled ring. The 2-cycle engine, which is valved by piston ports, presents a serious problem in cylinder lubrication for the top ring belt. Popular examples of this type of engine are the 71 series GM diesel and the GM electromotive diesel.

These engines operate under marginal lubrication conditions during a large percentage of the time, and it has been found necessary to develop compression rings of the filled type to obtain satisfactory engine performance and life.

In the case of the GM 71 series, a special tin-grooved compression ring, in which the groove is only partially filled with tin, Fig. 2a, was found to meet the requirements of high temperature operation under marginal lubrication conditions. This ring apparently functions again by depending, in

emergencies, on the molten tin, to serve as a lubricant. The grooves fill with carbonaceous matter which absorbs oil, helping this ring to operate satisfactorily over dry periods.

The second type of filled ring, shown in Fig. 2b, is one which does not employ a soft metal, but a chemical filler baked into the grooves. This filler is porous and will absorb large quantities of oil. During periods of marginal lubrication, the filler will release the oil; during periods in which surplus oil is available, it will reabsorb the lubricant. This ring has been very successful in the GM 8½ in. electromotive diesels and is the only type of ring which will operate a million miles in locomotive service without trouble.

#### Cylinder Finishes

The cylinder finish has an important influence on the success of a ring installation. In the past, there has often been the desire to make cylinders as smooth as possible with the expectation that such very smooth finishes would make for the longest life and most satisfactory performance of the installation. A rather intensive research program has proven this to be erroneous.

A long series of tests have shown that the most desirable surface for cylinder bores is an interrupted one consisting of small flat plateaus separated by deep channels. It was found desirable to have the channels as deep as 0.001 in. and the plateaus approximately 0.005 in. wide. In this surface, the channels or grooves are filled with carbonaceous matter in a short period of normal operation.

This material absorbs oil which it will release under the inducement of higher temperatures when needed. Since cylinder and ring wear take place only when the oil film breaks down, the presence of this oil reservoir in the entire surface of the cylinder reduces the periods of improper lubrication to a fraction of their normal duration.

Such interrupted surfaces properly produced have increased engine life under severe operating conditions as high as 200% in very high specific output engines. The additional advantage of the interrupted surface is its scuff and score impeding action.

# Rapid Power-Package Replacements Promote Airline Flight Regularity

rest of paper

By R. W. LAHNERS

Trans World Airline, Inc

AIR carriers will recoup thousands of revenue dollars now lost by flight delays as soon as engineers erase the technical difficulties now handicapping quick-change engine packages, predicts Lahnners. He maintains that: Changing the complete power egg when an engine goes wrong eliminates flight delays. Operational spares send flight on its way, while diagnosis of the faltering engine takes place on the ground.

Here is how this new maintenance technique would operate under ideal conditions:

A pilot having engine trouble in the air (it might be sticking valves, bad spark plugs, or a faulty fuel injection system) radios a major base. Upon landing, a ground crew is ready with a complete power unit, including propeller and accessories, already ground-stored. In less than an hour the crew replaces the power egg, ground checks it, and the pilot is ready for take-off.

## Reality Less Bright

But this is the ideal situation, still a long way from realization. Serious obstacles awake one from this "plug-and-power" pipe dream.

Beside from the need for service and maintenance planning and revamped design thinking, this system must offer: (1) certified performance reliability; (2) spare power eggs; (3) minimum flight delay, and (4) lightning changes when it becomes commercially feasible. These three responsibilities rest heavily with the test cell operation.

Test cell must test engines after overhaul, assuring satisfactory performance of quick-change units. It must check out and trouble shoot malfunctioning power eggs.

There are at least four ways of testing power eggs.

In the first method, the engine and accessory are tested as separate units, assembled in the power egg, and performance of the completed assembly is checked on the airplane. This is for best handling of each unit for easy isolation and correction of possible malfunctions.

It also requires special test equipment for each item and the engine must be equipped with a special test and special test accessories. This method has been found to open the door to errors and maladjustments.

Righting these troubles robs the power unit of its quick-change virtue.

Method two prescribes testing the engine and each accessory as separate units; building them into a power unit, complete with propeller; and ground checking the whole assembly on a special test stand. The power egg and propeller can be transferred to the airplane as a complete unit.

This approach has an advantage over the first method in that it reduces ground time and trouble shooting to a

minimum. But again special test facilities and instrumentation must be provided. The combination propeller and power egg makes a cumbersome package so that shipping such assemblies is practical impossible. The flight propeller also complicates the testing operation.

In the third method, the engine and all accessories are assembled into the power egg and the unit tested as a whole. This minimizes both test time and special test equipment. But test

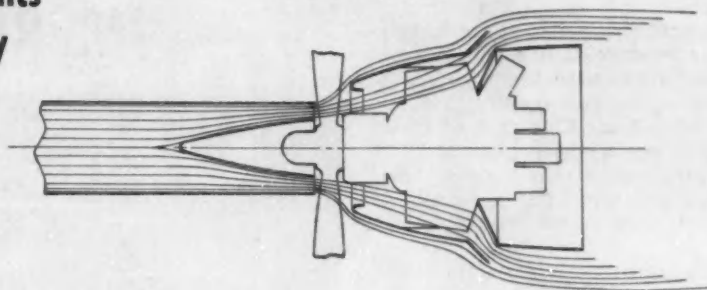


Fig. 1 - Cooling of the Constellation power egg on the test stand was a major problem. Precious cooling air was lost around the cowling

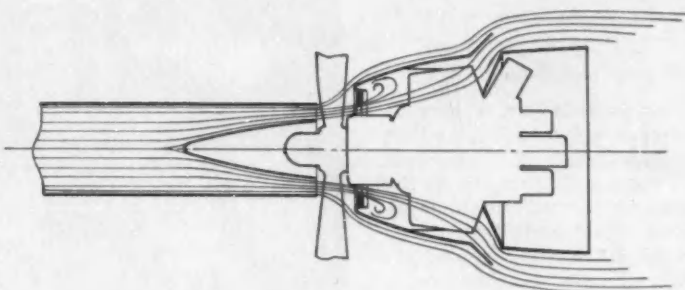


Fig. 2 - An experimental dam - designed to build up total air pressure inside the power egg cowling - backfired. It kept air out instead of forcing it through the cylinders

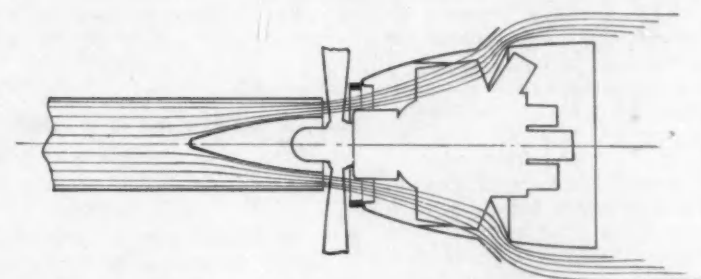


Fig. 3 - In this attempt to decrease cooling air loss in testing the power egg, a cowling extension was built. But it proved to be structurally, rather than functionally, unsound

results are not entirely satisfactory. Required checks cannot be made and detection of troubles approaches the impossible.

The fourth method requires testing of each accessory as a separate unit, assembling them with the engine into the power unit, and making the required engine test. This method gives each accessory a thorough check so that all malfunctions are corrected before assembly into the powerplant. No special engine test mount is required.

But this method requires flight cowlings so that engine cooling, fuel metering, and control linkages are among its several disadvantages. Trans World Airline is now using the last method for testing the Constellation power egg. Cooling the power unit during test is just one of the problems that had to be solved.

#### Cooling Installation

The cooling installation, shown in Fig. 1, consists of a 500 hp blower that supplies air through a 28-in. conduit. An inverted cone in the mouth of the conduit increases air velocity and directs it at the cylinder. But as shown in Fig. 1, a high-velocity layer of air is directed around the cowlings and is wasted.

As a remedy, a doughnut-shaped plate was installed in the mouth of the cowlings to act as a dam, Fig. 2, so that air would be trapped behind the dam. Static pressure would build up until sufficient air would be forced through the cylinders. But in practice, the dam did just the opposite; it kept cooling air out of the cowlings.

Another attempt to confine the cooling air inside the cowlings consisted of a circular ring to close the gap between the propeller and front edge of the flight cowlings, shown in Fig. 3. But the ring was flimsy and its service life was too short. Best results were obtained by omitting the built-in cone from the mouth of the blower nozzle and substituting a flight-type spinner.

#### Present System Slow

In addition to these test difficulties, present power-egg changing is far from quick. A four-man crew can replace a power egg in about 8 hr. (A set of spark plugs on the Cyclone 18 can be changed in 2 hr by this same crew.) But design modifications such as plug-in type pressure connections and quick-connect fittings can accelerate realization of plug-in power.

While power egg replacement has its headaches now, the benefits it offers more than justify expenditure of engineering effort to eliminate these shortcomings. (Paper "Complete Power Egg Ground Testing," was presented at SAE Annual Meeting, Detroit, on Jan. 10, 1947.)

## ELECTRONIC DEVICE IMPROVES PYROMETRY

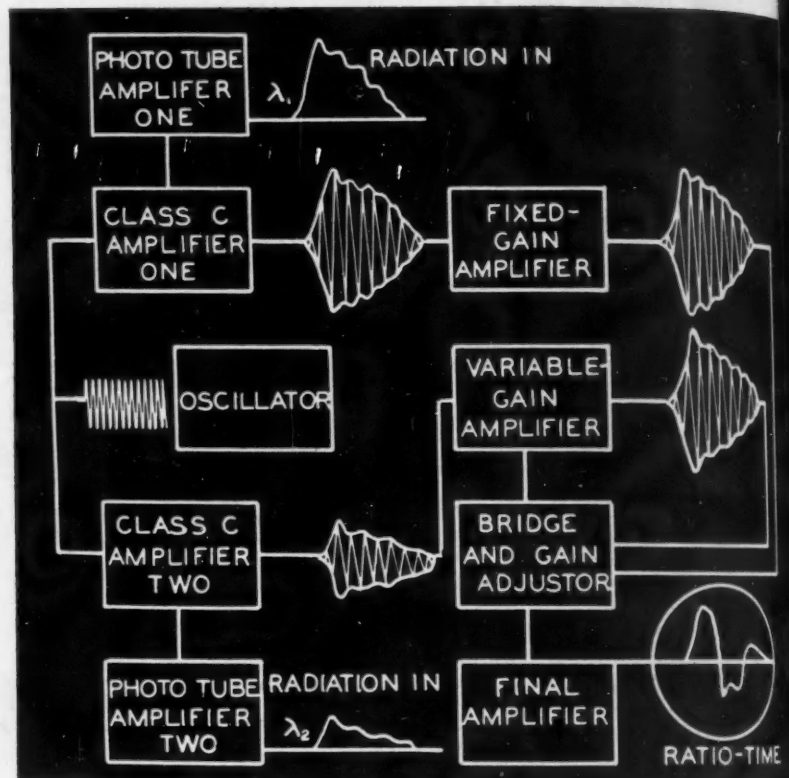


Fig. 1 - Schematic diagram of electronic circuit for measuring true temperature as a function of light intensities at two wavelengths

Digest of paper

By P. S. MYERS and O. A. UYEHARA

University of Wisconsin

(This paper will be published in full in SAE Quarterly Transactions)

**A**n electronic circuit arrangement which facilitates pyrometer measurements of diesel combustion-chamber gas temperatures is reported by the authors. This device solves instantaneously an equation, derived from Wien's Law, relating true temperature to intensity and wave length of monochromatic radiation from a luminous flame. True temperature is indicated on an oscillograph.

Explaining their electronic circuit, the authors say:

If Wien's Law is applied to two different wave lengths, it can be shown that true temperature is a function of the ratio of the two radiation intensities. Their device, shown in Fig. 1, instantaneously measures the ratio of light intensities at the two different wave lengths.

At each wave length, a photo tube translates intensity into voltage. The voltage is amplified and led to a modulator. Also led to the modulator is a

455-kc per sec constant-amplitude carrier wave generated by an oscillator. Amplitude of the carrier wave coming out of the modulator is directly proportional to light intensity. The modulated carrier wave at one wave length is amplified a constant amount by fixed-gain amplifier. The modulated carrier wave at the other wave length is amplified by a variable-gain amplifier. Then both outputs are led to rectifier and Wheatstone bridge arrangement which detects any inequality in output and eliminates it by automatically adjusting the variable-gain amplifier. It is the voltage required to make this adjustment which is amplified and impressed directly on the vertical plate of a cathode-ray tube. The deflection on the tube is a measure of true temperature.

Temperature can be plotted as function of any variable, such as time and crank angle.

In the few data which have been collected, the cycles were not repetitive, but the general trend was reproduced. (Paper, "Flame Temperature Measurements—Electronic Solution of the Temperature Equations," presented at SAE Annual Meeting, Jan. 8, 1947.)

# NAvion Features Fool-Proof Flight

Digest of paper

By **STANLEY G. HELLMAN**  
and **ED SCHMUED**

North American Aviation, Inc.

**M**AXIMUM car-like safety and comfort highlight the characteristics of the 4-place, all-metal NAvion, according to Hellman and Schmued. Describing some of the design features responsible for achievement of these qualities, they point out that:

Design of the NAvion wing makes for low landing speed and high performance, coupled with safe flight characteristics. It's designed so that the section nearest the fuselage stalls first. In other words, the tip section is still flying and aileron control is maintained up to and through the stall.

With power off, aileron control is excellent down to stall speed. But power-on stall in an early model produced a sharp right roll. Investigation showed that power-on stall occurred at an angle of attack 4 to 5 deg higher than the power-off stall.

Placing triangle spoilers on the wing leading edge, outside the propeller slipstream, resulted in desirable characteristics—a straight-ahead stall with power on and no loss of  $C_L$  with power off.

Flight simplicity is enhanced by an interconnecting spring between the rudder and aileron controls. Perfected as a device to produce lateral stability to prevent spiral in a slideslip, it permits practically 2-control flight. Right rudder movement causes right roll movement of the aileron.

Aileron force also is applied to the rudder cable through the interconnecting spring.

The NAvion comes well within the CAA requirement of a 1-turn spin. The utility version has a 20% aft c.g. position and cannot be spun. The normal category NAvion—with a 16 to 32% c.g. range—recovers from this spin in from one-quarter to one-half turn.

The tricycle landing gear makes landings easier and safer. It also provides better visibility on the ground and better ground handling. The nose-gear wheel—when retracted—extends slightly from the wheel well. This produces a rolling contact with the ground, minimizing damage to the airplane in case of gear-up landing.

The gear is held in the "down" position by a gear-to-fixed-structure linkage. An emergency release on the control panel unlocks the gear should the regular system fail. A visual gear-position indicator flashes and a warning horn sounds when the gear is in an unsafe position for landing.

A combustion-type heater, operating

on fuel from the regular fuel system, maintains passenger comfort and prevents windshield fogging.

Taking a cue from the Navy, the NAvion's designers have installed red lights for panel instruments. The Navy found red lighting lessened pilot eye-fatigue and improved night eye adaptation. Pilots could look at outside light sources, then back at their cockpits with minimum time loss for eye adaptation.

Another comfort feature is the spring and airfoam-upholstered seat cushions. Individual pilot and front-passenger seats are adjustable, fore and aft.

These and other features make the NAvion an easy-to-fly airplane with characteristics pleasing both the novice and the experienced pilot. (Paper "A Design Description of the NAvion," presented at the SAE Annual Meeting, Detroit, on Jan. 9, 1947.)

## Valve Vulnerability To Heat Vanquished

Digest of paper

By **VINCENT C. YOUNG**

Wilcox Rich Division  
Eaton Mfg. Co.

(This paper will be published in full in SAE Quarterly Transactions)

**T**AKING poppet valves off their hot seats to lengthen valve service life resolves itself into the offsetting of out-of-round temperature gradients with devices such as cooled and rotator valves and corrosion-resistant materials, says Young. He shows that:

Uneven temperatures will distort conical valve-seat shapes and destroy the seal against gases. Fig. 1 shows the variation in temperature around

the seat circumference for a given operating condition.

To combat this uneven circumferential temperature, methods such as the rotator valve, sodium cooling, and use of corrosion and wear-resistant material on both valves and seats have met with success.

Greater improvement in valve life has been realized with valve rotation than with any other remedy. Rotation does not keep the valve seat near the out-of-round cylinder seat long enough to change the angle of the valve face and stem axis. But with the nonrotating type, this angle can change considerably under some conditions so that the seat contour will vary and increase the leakage area.

With oval seats, deposits tend to build up unevenly. When a sector of turn to p. 70

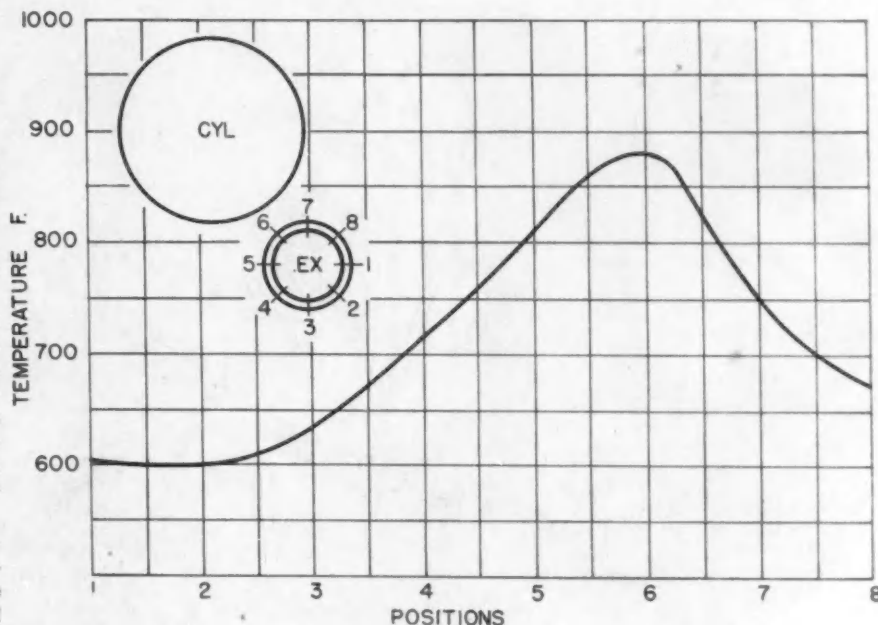


Fig. 1—Demonstrated here is the variation in temperature on the circumference of a valve seat insert

# Care Key to Durability Of Special Tire Types

Digest of paper

By L. W. FOX

Firestone Tire & Rubber Co.

**L**ACK of proper maintenance nullifies heavy-duty features of tires tailored to unusual operations of on- and off-the-road equipment, says Fox. He points out that:

These five tire types, shown in Fig. 1, are built for special jobs:

- a. Maximum traction type,
- b. Free-rolling type,
- c. Highway type,
- d. Rock type,
- e. Extra-deep traction type.

Designing a tire for maximum traction in off-the-road work, consideration must be given to items such as tread shape, bar shape, angle and spacing of bars, roadability, cleaning, and durability. The diagonal bar tire, Fig. 1 (a), is the only type suitable for this kind of work.

It cleans much better and makes for more efficient traction. But the diagonal must be applied in the proper direction of rotation so that the soil moves out of the openings between the bars as the tire works.

Considerable space between the bars provides the necessary gripping power in loose soil. It also imparts a self-cleaning characteristic in soils that fill up the design and decrease traction.

For free-rolling wheels, it's customary to use a tire with a button design or all-over pattern, as shown in Fig.

1 (b). Such closely spaced designs resist cutting and snagging and protect the tire body.

For earth-hauling on the highway, a design similar to ordinary truck tires with some traction feature for limited use off the road seems to fill the bill. Such a tire is shown in Fig. 1 (c).

Rock tires are specifically designed for durability in rocky operations. As seen in Fig. 1 (d), this is a traction-type design with close spacing for protection of the tire body. For this reason they are not efficient for traction in loose soils.

Rock tires are built to hold up under a lot of abuse. They have large bulky traction elements; extra body and tread plies; extra rubber inserts; cut-resisting treads, and heavy sidewalls. Of course, these features boost the tire price.

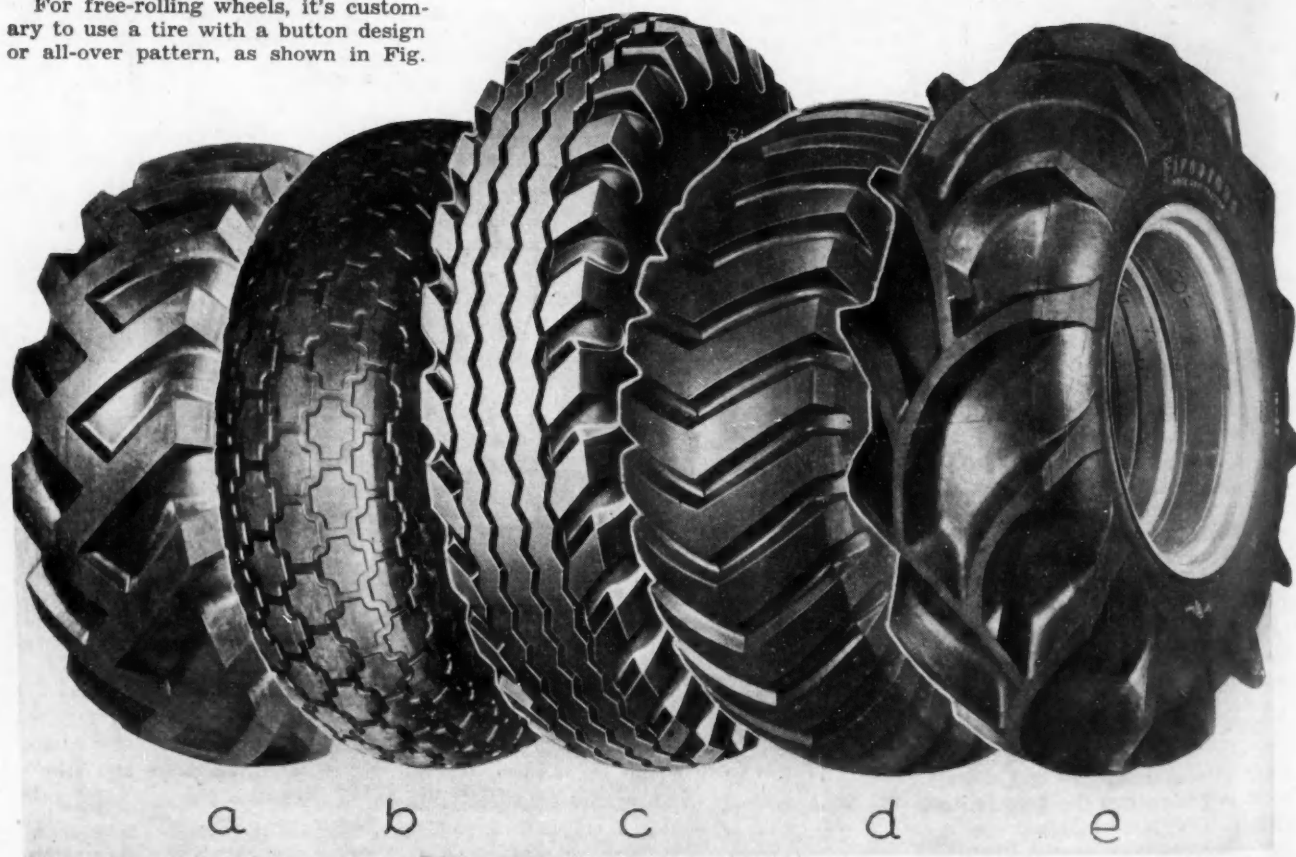
Cane and rice fields are very soft—especially during certain seasons—and equipment for these operations needs extra traction. Farm tractors in this kind of work are being equipped with the extra-deep traction tire, shown in Fig. 1 (e). While the special tractive ability is needed in the fields, the machine must travel over hard roads to the mill. Both of these requirements must be met by the tire for economical and satisfactory performance.

Although of rugged construction, tires for heavy hauling operations are more often retired from service because of damage than wear. But in view of the conditions under which these vehicles operate, some of this premature failure is understandable. Rock-strewn roads, rocky shoulders, and unusual grades, are just a few of the hazards.

However, many "accidents" are not attributable to road conditions or operational severity. You can mark these up to plain carelessness and poor maintenance. Just a few of these items taken from on-the-job reports are:

turn to p. 70

Fig. 1—These tires are designed for special operations: (a) maximum traction type for off-the-road work in loose soil, (b) free-rolling type, (c) highway type for on-the-road earth hauling, (d) rock tire for operations over rocky terrain, and (e) extra-deep traction type for tractor operations in cane and rice fields



# Abnormal Conditions Foster Diesel Smoke

Digest of paper

By DR. P. H. SCHWEITZER

The Pennsylvania State College

(This paper will be published in full in  
SAE Quarterly Transactions)

**W**ELL-DESIGNED diesel engines in good repair need not smoke while being operated on normal fuels if prevented from being overloaded, says Schweitzer. Discussing causes and cures for diesel engine smoke, he points out that:

Diagnosis of smoke type should precede the remedy of a smoky exhaust condition. While they seldom appear singly, the two types of diesel smoke are: (1) "hot smoke"—resulting from sluggish burning of fuel particles—and (2) "cold smoke"—composed of fuel particles ignited too late or not at all.

Hot and cold smoke often appear side-by-side because some fuel particles ignite, but fail to complete combustion in the cylinder at exhaust opening, while others never ignite.

Main reason for incomplete or sluggish combustion (cause of hot smoke) is an overrich mixture. Even with a lean air-fuel ratio, the mixture can be overrich in spots. Local overrich conditions with a lean overall condition is the most common cause of diesel exhaust smoke.

Anything that improves mixing, reducing local overrichness, also improves smoke condition. Poor atomization, poor spray distribution, and insufficient turbulence cause local overrichness and exhaust smoke. Fig. 1 shows that a defective or dirty nozzle frequently causes exhaust smoke. Keeping the engine in good repair avoids such invitations to smoke.

Late ignition (cause of cold smoke) comes from late injection, long ignition lag, or a combination of the two. Advancing the injection timing will correct late injection. Too long an ignition lag cannot be cured in such an easy manner.

Compression temperature, compression pressure, or compression ratio may be increased. If a chilled combustion chamber is responsible for ignition lag, the chamber may be made hotter.

Cold smoke can be traced to engine overloading.

A normal engine burns normal fuel without exhaust smoke between one-quarter and three-quarter load. But as shown in Fig. 2, smoke density increases rapidly as full load is approached and exceeded. This comes from an enriching of the fuel-air mixture and from a lengthening of the injection period, making for late burning of the injected fuel.

Fig. 1—A defective nozzle is an invitation to diesel exhaust smoke. These two curves were obtained under identical conditions, except for nozzle condition

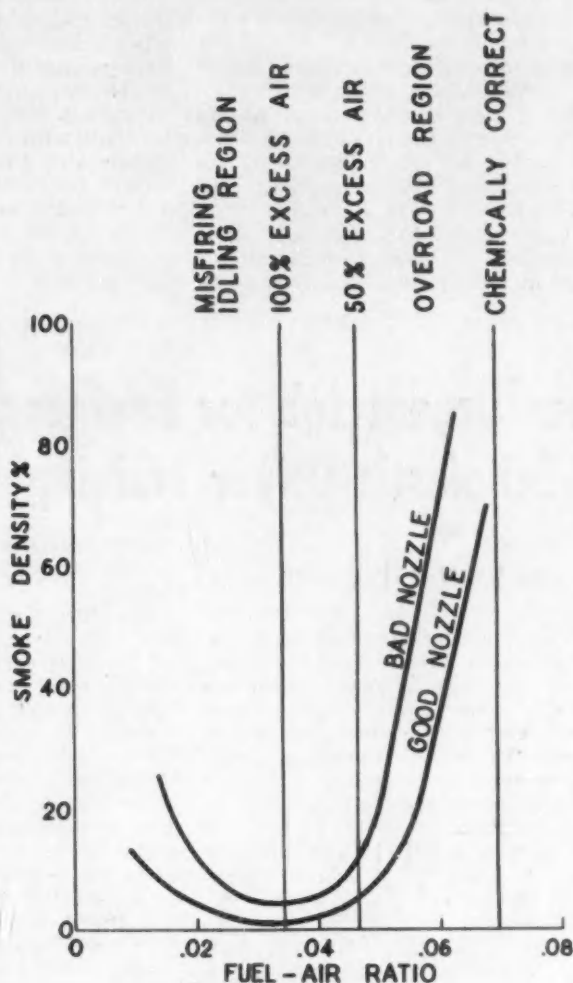
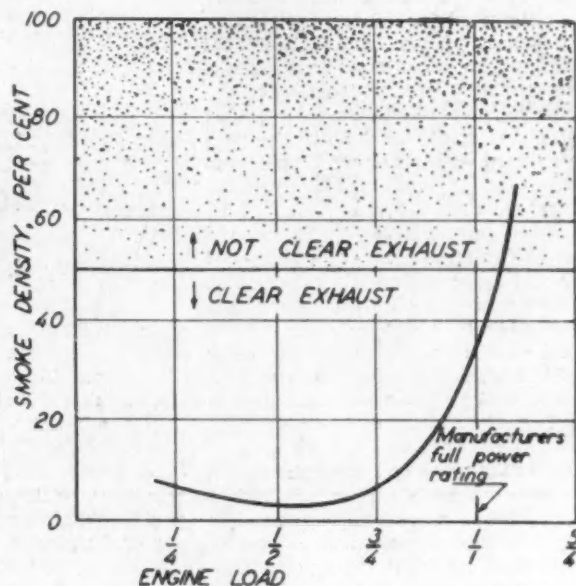


Fig. 2—This demonstrates the effect of engine load on smoke density. Overloading the engine will quickly bring on smoky exhaust



At light loads, near misfiring, cold smoke appears because part of the fuel fails to ignite and produces fog, and part of the fuel ignites too late to complete combustion.

As for the influence of fuel on smoking, investigations show that an increase in fuel cetane number should improve cold smoke and aggravate hot smoke. The net effect depends on actual conditions. Under prevalence of cold smoke—as with low compression ratio, low cetane fuel, light load, or a combination of these factors—an increase in fuel ignition quality will de-

crease smoke. If hot smoke predominates, an increase in cetane number will increase smoke.

Under normal conditions, smoke is fairly independent of the fuel's ignition quality with fuels between 40 and 60 cetane number.

Analysis shows no compromise need be made with annoying diesel smoke. Better mixing of the fuel and air will correct hot smoke; speeding up ignition will eliminate cold smoke. (Paper "Must Diesel Engines Smoke?" was presented at SAE Annual Meeting, Detroit, on Jan. 8, 1947.)

stallation since they obviously reduce drag. But few airplane mechanics are familiar with flush-riveting procedures. While these airplanes are too new to have undergone major structural repairs, considerable training and tooling must be undertaken this year to prepare for the job ahead.

More costly maintenance for the future is a certainty.

Another structural improvement incorporated in 1947 transports is the new aluminum alloy, 75ST Alclad. Extensive use is made of this material in highly stressed parts since its tensile yield point is about 40% higher than that for 24ST. Designers estimate an 800-lb saving by using this material in a typical large commercial airplane.

Difficult working and forming of 75ST offset, to some extent, its high strength. Dimpling and joggling can be done only at high temperatures. Dimpling tools require special built-in electrical heating elements.

Only thinner gages can take shearing and punching; and then, only if sheared edges are carefully burred and polished. Thicker gages must be sawed or worked with cutting operations. Increased bend radii, annealing before bending, and identification difficulties are other problems that will plague the maintenance crew.

Laminar flow or low-drag wings built for some of the new high-speed transports require maintenance of a smooth, polished wing and an accurate wing contour. Scratches and dents, usually experienced in maintenance and servicing, will have to be avoided. While thicker skin plating for wing center sections affords some protection, the plane's performance will deteriorate with time unless special precautions are taken to preserve the low-drag sections.

Pressurized airplanes are flying higher and faster than older equipment, thanks to greater pressure differentials than ever before possible. But pressure leakage is more severe. Already accidental depressurization has been experienced in flight—a real passenger hazard. Maintenance crews must thoroughly inspect windshields, hatches, windows, and doors.

Two design innovations that permit greater payloads without further burdening ground operations are higher

## Sees Urgent Job for Engineer In Scholastic Driver Training

Digest of paper

By JOHN F. CREAMER

Wheels, Inc.

**D**RIVING education must begin at high school level to quell the rising tide of car accident fatalities in the teen-age group and to insure safe, skillful drivers in coming generations, Creamer advises. Discussing a three-point program in which SAE members can assume constructive leadership, he points out that:

Automotive engineers can promote driver training programs in local schools by:

1. Consulting with authorities;
2. Guiding the preparation of curriculum and selection of instructors;
3. Assisting in the acquisition of equipment.

Many school administrators must be sold on the need for driving instruction in the school. They believe it should be confined to vocational institutions. Obviously the limited proportion of the secondary school population attending vocational institutions defeats the program's intent—reaching all high school students.

Educators and the public should be apprized of the fact that motor vehicle deaths in the less-than-20-year-old driver group are five times greater than those in the 45 to 50 year age group. Yet only 1% of the 25,000 high schools in this country now offer behind-the-wheel training.

On the college level too safety education is sadly lacking. Only a handful of the 700 colleges and universities in the United States offer training in traffic safety. Institutions of higher learning as well as off-campus training bureaus, private schools, and extension services are fruitful prospects for adult education.

Once training programs are initiated, the engineer is well-equipped to assist in teacher training. His assistance is

equally valuable in the preparation of modern instructional materials and devices.

The third contribution the automotive engineer can make is helping to get training cars. Men in both sales and technical work in the automotive field are in favorable positions to make the right contacts.

The engineer has a civic as well as a personal stake in the lives of children—his own sons and daughters and those of relatives and friends. It's his moral obligation to stimulate, promote, and actively participate in the teaching of driving safety. (Paper "What Can the Automotive Engineer Do to Promote Safety in the Schools?" was presented at a meeting of the SAE Virginia Group, Richmond, on Jan. 20, 1947.)

## Plane Design Progress Extends Ground Care

Digest of paper

By H. E. HOBEN

American Airlines, Inc.

**R**ECENT structural advances in transport aircraft convey to operators the mixed blessing of increased payload and improved performance along with new maintenance problems, advises Hoben. He shows that:

Features such as flush-riveting and dimpling, 75ST aluminum alloy, low-drag wings, and pressurized cabins foster increased revenue and at the same time call for revamping of maintenance techniques.

Widespread use is made of dimpled and flush-riveted joints in modern transports such as the DC-4 and Con-

Table 1 — Comparison Demonstrating Effectiveness of High Wing Loading

	DC-3	CV-240*
Gross weight	25,000 lb	39,000 lb
Passenger capacity	20	40
Wing area	987 sq ft	817 sq ft
Wing span	94 ft 7 in	91 ft 9 in

\* CV-240 design speed is 70 mph faster than DC-3. Although its wing supports 14,000 lb more than DC-3 wing, it weighs only 500 lb more.

wing loadings and simplified landing gear.

In fact, high wing loading (70 psf for 4-engine airplanes and 45 psf for 2-engine transports) not only means less wing to build, it reduces the amount of wing to maintain. Table 1 illustrates the effectiveness of high wing loading in the new twin-engine CV-240 compared with the DC-3.

Tricycle landing gear with dual wheels are structurally more efficient than the tail wheel type. For comparison of the two, let's turn to the tail-wheel DC-3 type—which supports 25,000 lb.—and the CV-240 tricycle type—which supports 39,000 lb. Although the CV-240 gear includes a steerable nose wheel and dual wheels all around and is more rugged and dependable, it weighs only 1581 lb.—16 lb lighter than the DC-3 gear. (Paper "Trends in Aircraft Structures," presented at SAE Annual Meeting, Detroit, on Jan. 10, 1947.)

## Standards Broaden Small Plane Market

Digest of papers

By J. B. HIDAY

Delco-Remy Division, GMC

**S**TANDARDIZATION of personal plane electrical equipment will evolve car-type luxuries at low cost, says Hiday. He shows that:

Already aircraft equipment has been developed by modifying high production automobile units. Standardizing pole shoes, brush rigging, commutators, field coils, laminations, and armature windings permits tooling for large quantity production.

This type of planning must be extended to other parts of the personal plane.

For example, manufacturers must provide the personal plane market with radios, retractable landing gears, flaps, landing lights, and windshield wipers. These increased electrical loads will necessitate larger generators and batteries.

Standardizing on larger batteries appears to be advisable for several reasons. For one, battery ignition on aircraft is on the way. While CAA regulations present generator capacity problems using battery ignition, the overall system will be lighter, cheaper, and more reliable than the present installation.

Bigger batteries also come into play in dealing with starting.

The cranking motor is one of the most important electrical units on the airplane. Propping the airplane is unpleasant, dangerous, and practically impossible with some new planes. The cranking motor makes starting a one-man job.

But weight restrictions on the battery and cranking motor combination have penalized starting performance. The best performing airplane in the world is useless if it cannot be started.

Increasing battery size and starting motor ratio can improve starting performance. However, high starting motor ratios are hard to get at a low price. Just what ratio and battery combination should be selected depends on several factors, of which minimum temperature for cold weather starting is important.

Another area where standardization makes for wise economics is mountings pads for generators and starters.

## New Ejectors Boost Thrust, Aid Cooling

Digest of paper

By WILLIAM A. CLEGERN

Consolidated Vultee Aircraft Corp.

(This paper will be published in full in SAE Quarterly Transactions)

**R**ECENTLY developed ejectors are reported to make good use of engine exhaust energy to increase thrust without the addition of fuel and to pump cooling air. After discussing the development leading up to use of ejectors in a production model, the author says about the Convair 240:

Ejectors will provide an estimated 200-lb thrust per engine at 115 mph in a full-power climb. Their thrust increases with increasing altitude; at high power climb, the rate of increase is about 5 lb per 100 ft. Though airflow falls off with increasing altitude, velocity at the ejector exit, due to temperature and density changes, increases at a rate great enough to produce the

An SAE technical committee already is developing such standards, although standard mountings will not be in use for some time.

Bringing personal plane prices down to within reach of many demands institution of every possible cost-reducing measure. Increasing production of standardized units is a step in the right direction. (Paper "Electrical Equipment for Personal Planes," presented at SAE Mid-Continent Section, Ponca City, Okla., Dec. 6, 1946; paper "Adaptation of Automotive Electrical Equipment for Personal Aircraft," presented at SAE National Personal Aircraft Meeting, Wichita, May 2, 1947.)

thrust gain. Ejector thrust decreases with increasing speed.

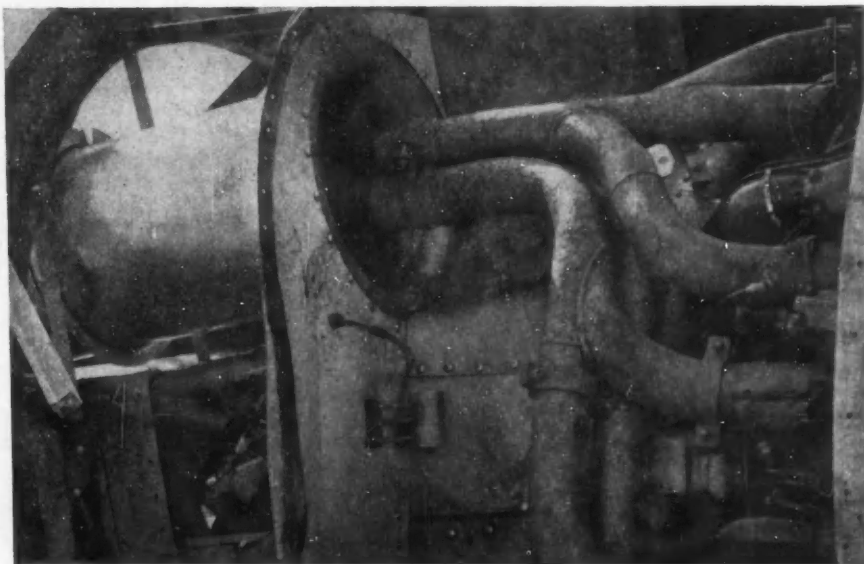
Cooling tests run on the stand show that the engine can be cooled well below the limits on a 100-F day at any power. Even spark-plug elbows are under the limit.

On each engine of the Convair 240, exhaust gas from the 18 cylinders is discharged through stacks into two ejectors. Each one of the three branches of a stack collects exhaust from one cylinder. Three stacks are aimed into each ejector as shown in Fig. 1. The ejector exits are rectangular.

The design seems to be superior to the collector-ring setup used previously on other planes.

Assuming that use of the ejector eliminates the heat exchanger or combustion heater at a saving of 40 lb, the latest ejector installation adds only a total of 128 lb per engine. (Paper, "Recent Developments in Thrust Augmentation as Applied to Radial Engine Installations," presented at SAE Annual Meeting, Jan. 10, 1947.)

Fig. 1—Branched exhaust stack installation on test stand



## Special Tire Types

cont. from p. 66

valve stem broken by rocks; cut by dozer blade; bead failure—damaged rim; cut by falling rock in loading.

Impact failures rate high. They can be traced to overload, high speed, obstacles in the road, or overinflation. Some impact failures start from cuts.

Translated into down time, these tire failures total up to a surprising dollars-and-cents loss.

For example, if we had a 12-yd unit moving material at 30¢ per yd, making four trips per hr, it is earning \$14.40 per hr. Keeping the machine out of service 3 hr because of tire trouble incurs a \$45.50 production loss. You can create your own hypothetical case for any given job and determine the losses.

Obviously preventive maintenance can lengthen tire life. Here's a five-point maintenance program that should more than pay for itself:

1. If considerable variation is found in pressures between regular check periods, find the cause. It may be a puncture, bad valve, or chafed tube. Detecting the cause early can prevent serious delay later;
2. Regularly look for and remove small stones imbedded in the treads. These work into the tire body and start trouble.
3. Rocks between duals can be disastrous. They are easily seen and easily removed.
4. Watch inflation of inner duals. They are hard to get at. But valve extensions, while sometimes used, result in slow leaks and inner tube trouble.
5. When spin cuts become excessive, find the cause and correct it. (Paper "Types and Constructions of Tires for Heavy Hauling Equipment," presented at SAE Peoria Section, on Oct. 28, 1946.)

## Valve Vulnerability

cont. from p. 65

this deposit breaks away, leakage can become excessive. Constant rotation exposes no portion of the valve face to the leakage area long enough to allow a temperature build-up in the corrosive range.

Sodium cooling permits a better choice of steels since, by operating cooler, it reduces appreciably the high hot strength required of the material. In critical applications the cooled valve resists the cylinder seat's tendency to distort, extending good seating life.

Corrosion and breakdown of valve head material into iron oxide beyond certain temperatures can influence detonation. Cooling the temperature below the value at which corrosion is accelerated yields better engine performance with a given fuel.

Special materials for valves and seats resist both high temperature deformation and wear.

Data accumulated evidence the marked increase in valve life realized with these modifications in many types of operations. (Paper "Considerations in Valve Gear Design," presented at SAE Annual Meeting, Detroit, on Jan. 7, 1947.)

## Reveals New Pickups for Detonation Tests

Digest of paper

By J. S. BOGEN and W. J. FAUST

Universal Oil Products Co.

(This paper will be published in full in SAE Quarterly Transactions)

**A** NUMBER of aircraft detonation indicators for both laboratory and flight operation work are described and their applications discussed in a summary of wartime development. After detailing the construction features of each indicator, the authors go on to say:

One indicator is based on the ionization characteristics of a burning charge of fuel. The others all respond to cylinder-head vibrations.

Unwanted pickup signals from valves and extraneous combustion vibrations are eliminated in several instruments by a mechanical commutator. Others drown the weaker signals by means of electronic switches, triggered amplifiers, threshold amplifiers, or manual decrease of the sensitivity.

Methods of indication include both the oscilloscope for experimental laboratory and flight testing, and steady-reading meters or instantaneous peak-reading meters for either laboratory or flight testing. For routine flight operation, detonation is indicated by a flashing neon light.

Flight tests with detonation-indicating equipment enabled one airline to reduce piston failures from 6.8 to 1.5 per 10,000 hr by readjusting carburetor settings to avoid detonation at take-off.

Safe values for minimum specific fuel consumption have been set by exploring the effect of various fuel rates on detonation. As much as 34% of the fuel used under typical airline procedure for level cruise conditions may be saved by maintaining fuel flow just high enough to safely avoid detonation. Even the average fuel saving of 20% accomplished with the in-

stallation of a 120-lb indicator can result in a significant saving in net weight. (Paper "Aircraft Detonation Indicators," presented at SAE Annual Meeting, Detroit, Jan. 9, 1947.)

## Speed, Density Used To Meter Fuel Flow

Digest of paper

By JAY A. BOLT

Bendix Products Division

(This paper will be published in full in SAE Quarterly Transactions)

**A** FUEL injection device for aircraft engines which meters fuel in response to engine rpm, intake manifold temperature, intake manifold pressure, and exhaust back pressure is discussed by Jay A. Bolt. With this speed-density device, the whole engine is an air meter, and the available forces are not limited to the suction of an air venturi. Describing one Bendix unit, the author explains:

Three components govern the flow of fuel. Thrust generated by rotating governor weights of one component controls a poppet valve in such a way that flow is approximately proportional to engine speed.

Two bellows in a closed housing regulate fuel flow in accordance with manifold and exhaust back pressure requirements. The housing is vented to manifold pressure. The larger bellows is evacuated, but the interior of the smaller is vented to atmospheric or exhaust back pressure. The assembly moves a contoured needle which controls the metering-jet area.

By means of another contoured needle, a third assembly meters fuel in relation to engine intake-manifold temperature. The change in fuel flow per unit of temperature change is adjusted to correspond to the change in airflow at one manifold pressure. The arrangement does not provide an exactly constant fuel-air ratio at other manifold pressures.

An idle spring adjusts the metering head to give the proper idling mixture.

These controls are used with a throttle-actuated accelerating pump, an air throttle valve for controlling engine power, and either a constant-pressure fuel discharge nozzle for spraying the fuel into the air stream or means for discharging the fuel through holes in the supercharger impeller.

Among the advantages of the system are elimination of metering variations caused by air-scoop effect, higher metering forces, a metering unit and air throttle lighter than the carburetor and separate fuel pump, and greater flexibility in installation. (Paper, "Fuel Metering by Engine Speed and Manifold Density," presented at SAE Annual Meeting, Jan. 6, 1947.)

# TECHNICAL COMMITTEE PROGRESS

## Explore Wider Use Of Cold Drawn Steel

A new division of the SAE Iron and Steel Technical Committee has been set up to canvass fully the present uses of cold drawn steel and to explore the broader applications of this type of steel. Both producers and users of cold drawn steel feel that the possibilities of these steels have been neglected, and it is the hope of the Division members that a standard specification of cold drawn steels based on physical properties can be developed.

Chairman of Division XVII, Cold Drawn Steels, is Howard M. Smith, Wyckoff Steel Co. Other members of the Division include A. L. Boegehold, General Motors Corp.; George R. Caskey, Bliss & Laughlin Steel Co.; E. L. Hollady, Office, Chief of Ordnance; R. B. Hooper, Chrysler Corp.; H. B. Knowlton, International Harvester Co.; M. N. Landis, LaSalle Steel Co.; W. D. Reed, Jones & Laughlin Steel Corp.; R. B. Schenck, Buick Motor Division, GMC., and F. C. Young, Ford Motor Co.

The subject was first considered seriously toward the close of the war when early in 1945 Col. J. H. Frye, metallurgical chief of the Army Ordnance Department, proposed a study of the subject under SAE sponsorship.

Members of the new Division feel that the wide range of physical properties of steel that can be developed by cold working and the advantages that at times exist in processing cold worked products afford a marked reduction in man-hours and production costs. Cold drawn steel will machine at from two to six times the speed of heat treated steel, it is held, and less steel need be taken off cold drawn in the machining process.

In considering possible new applications of cold drawn steel, questions raised with respect to its use include how far it is possible to go without destroying the impact strength, the relieving of trapped stresses, and the relative shear in comparison with hot rolled steel.

After these properties have been determined, it

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will be necessary for the using manufacturers to decide what these steels can be used for in the automotive industry. That phase of the problem is the end objective of the project. The greatest possibility for cold drawn steels in the automotive industry seems to lie in the range of yield strengths between 70,000 and 110,000 psi.

#### Finding Applications

A survey of the field of possibilities made by the Division and based on successful usages now being made by members of the Division show the following highly probable applications:

Bolts, threaded spring U-bolts (90,000 psi.) and cylinder head studs, rolled and threaded at both ends, during which the psi. goes from 100,000 to 130,000 (tension and yield strength are required of these parts); starter motor shafts, splined and with key ways; small pinions, oil pump and crankshaft gears, requiring torsional resistance; propeller drive shafts, transmission and clutch shafts which require torsional and bending resistance; shackle pins requiring wear resistance, and tubes for tractor and

implement axles, frames and seat supports.

Had the properties to be expected from cold worked materials been better known and recognized properly in specifications, undoubtedly industry as well as Army Ordnance could use them to greater advantage and much more extensively and with material savings in cost.

A better understanding of the engineering characteristics of this basic material would not only be an advance to science and industry but in all probability would contribute materially to industrial preparedness for national security.

As a starter, the Division has agreed to run tests using as a basic test specimen a currently used automobile propeller shaft splined at both ends. Tests will be conducted with specimens made from cold drawn steel (125,000 psi); cold drawn stress-relieved steel of the same psi, and heat-treated steel. A steel like SAE 1141 is suggested for the cold drawn, while either SAE 5140 or 8640, oil quenched, is suggested for the heat-treated steel.

It is expected that test work will get under way shortly.

## SAE Project Unlocks Passenger Car Bumpers

**E**LIMINATION of locking passenger car bumpers in parking or in sudden stops in congested traffic is aimed for by the SAE Bumper Heights Committee's recommendation that bumper heights above the ground be standardized at 18 in.

This project stemmed from requests from the Automobile Manufacturers Association and the American Association of Motor Vehicle Administrators. The bumper heights recommendations will not immediately better conditions, reports AMA, since they will have to be adopted by car manufacturers concurrent with other design changes on future models.

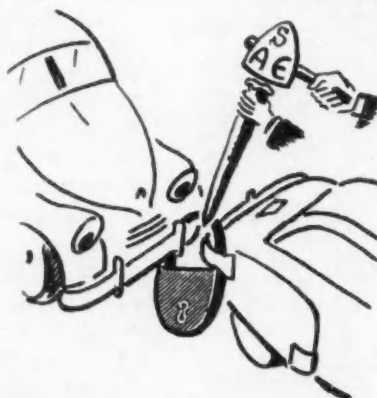
Extensive studies conducted by the Committee form the basis for these recommendations. Included was a uniform dive test under controlled conditions to determine the maximum amount of drop taken by front bumpers. It also served to determine the maximum amount of lift taken by rear bumpers with all cars carrying their full rated load and with cars brought to a full brake stop.

Four stops were made with each vehicle at three different rates of speed, namely: 5 mph, 10 mph, and 15 mph. Thus the range of heights above the ground in which bumpers would not

overlap or lock was determined.

The maximum amount of brake dive on 44 models tested was 6.44 in. and the minimum was 2.25 in. for front bumpers. Maximum brake lift was 7.87 in. and the minimum was 3.94 in. for rear bumpers.

Under normal full rated load conditions, the height of the top of front main bumper bars varied from 17.41 to 21.25 in., while the bottom of the bar varied from 11.91 to 15.97 in. Rear-bumper main-bar heights varied from 11.34 to 15.22 in. for the lower edge.



The space between the top and the bottom of vertical bumper guards varied from 9.69 to 16.97 in. for the front, and from 9.37 to 12.97 in. for the rear.

With these variations in bumper heights and dimensions, the dive tests showed that the average height of the top of the front bumper guards and the lower edge of the rear bumper at full stop between 5 and 10 mph was 18.25 in. This is the recommendation of the Committee.

It believes that if the recommendation is adhered to in future design, the locking of bumpers will be practically a thing of the past, as far as passenger cars, station wagons, and one-half ton trucks are concerned.

#### No High-Speed Protection

The Committee also points out in its report that, contrary to popular belief, it is not possible to fit bumpers to automobiles that will protect against collisions at speeds greater than 5 mph. The function of bumpers is to protect vehicles in low speed conditions, or when crowded together in parking. This means that all passenger car bumpers should be at substantially the same height above ground.

Along with the investigation made by the Committee on heights of bumpers, a study also was made (and data are on file) relating to bumper strength together with methods of checking bumper strength employed by various manufacturers.

In view of the variety of design factors, differences in weight and size of car, it was agreed that it would not be practical to attempt setting up a code calling for the same properties in all bumpers.

Any uniformity of bumper heights for trucks and buses seems to be out of the question, reports the Committee. Most trucks are equipped with front bumpers and, when design and operating conditions permit, with rear bumpers.

#### Truck Bumpers Heavier

Truck bumpers are intended to protect the vehicle. Since they are much heavier, they are more rigid than passenger car bumpers. Because of the increased impact to be absorbed where a truck is involved, passenger car bumpers provide less protection from damage in collision with a truck.

Bumper heights vary widely on trucks and are determined by the frame height of the truck. Frame height depends on the size and weight of the vehicle and the tire size. As the gross weight goes up, bigger tires and wheels are required. The bigger the truck, the higher the frame and hence the higher the bumper.

Data accumulated by the Committee shows that for all trucks larger than the so-called 1/2 to 3/4-ton size, there is

turn to p. 88

# SAE Advances Tire Size Listing For Future Farm Tractor Design

A RECOMMENDED practice list of tire sizes prepared as a guide to engineers in future designs of agricultural tractors has been submitted to the Tire and Rim Association by the SAE Tractor Technical Committee. It is hoped that the simplified list will be valuable in helping to keep the number of rear tire sizes at a minimum.

L. A. Gilmer, chief engineer of The Oliver Corp., directed the preparation of this recommended practice. He points out in the report accompanying the tire lists that, in the early days of the application of pneumatic tires to farm tractors, the combination of section and rim diameters was usually selected so that the tire loaded radius would match the radius of an existing steel wheel.

The advent of wide-base tires and the development of new tractor models resulted in a great expansion of tire and rim size combinations. Tractor and rubber engineers saw in this constantly increasing number of sizes both technical and economic disadvantages to the manufacturer and owner of the tractor.

"In those early tractor rubber tire days rim diameters varied by 4-in. increments from 24 to 40 in," said Gilmer in his report, "and the more popular sizes are shown in Table 1.

Table 1 - Conventional Tractor Rear Tire Sizes - Prior to the Wide-Base Program

Section Diameter	24	28	32	36	40
7.50	x	...	...	x	x
8.25	...	...	...	x	x
9.00	...	x	...	x	x
10.00	...	...	...	x	x
11.25	...	x	...	x	x
12.75	x	x	x	...	...
13.50	x	x	x	...	...

This does not include all sizes in production at the time the industry adopted the wide-base tire program, but does serve to illustrate the pattern the size ranges followed.

## Swing to New Rim Sizes

"Because the wide base tires had much lower section heights than the conventional tires, it was necessary in many cases to use rims of 2 in. greater diameter or tires of greater nominal cross sections or both, to match the loaded radii of the conventional tires or steel wheels previously used. This resulted in the introduction of new rim diameters between those used for the conventional tires.

"As new tractor models were developed, some manufacturers used these new rim diameters, while others continued to use the old. There was also the requirement to retain the old to

provide conventional tire replacements even though the tire designation had been changed to wide-base practice.

"This resulted in the situation illustrated in Table 2. All of the sizes shown were not in production in large

quantities, but had been produced in varying quantities for original equipment, replacement, or experimental purposes. (Note: Table 2 compiled from RMA list of tire shipments for 1945.) The items marked by an asterisk are the sizes approved by the former SAE Tractor War Emergency Committee for use by the industry during the war.

"The TWEC list was based on the elimination of oversizing and the use

Table 2 - Wide-Base Tractor Tire Sizes - Prior to Any Simplification Program

Section Diameter	24	26	28	30	32	34	36	38	40	42	44
6	2 ply	...	...	...	...	...	...	...	...	...	4 ply
7	2 ply	...	...	...	4 ply	...	4 ply	...	4 ply	...	4 ply
8	2 ply 4 ply	...	...	...	4 ply	...	4 ply 6 ply	4 ply 6 ply	...	...	4 ply
9	* 6 ply	...	4 ply	...	*	...	4 ply 6 ply	4 ply 6 ply	4 ply 6 ply	...	...
10	* 6 ply 8 ply	4 ply 6 ply	* 6 ply	...	...	...	4 ply 6 ply	* 6 ply	6 ply	...	...
11	* 6 ply	* 6 ply	* 6 ply	...	...	4 ply	4 ply 6 ply	* 6 ply	* 6 ply	...	...
12	4 ply	4 ply	...	6 ply	...	...	4 ply 6 ply	4 ply 6 ply	6 ply	...	6 ply
13	4 ply 6 ply	...	4 ply 6 ply	...	...	6 ply	4 ply 6 ply 10 ply	...	6 ply	8 ply	...
14	6 ply 8 ply	...	4 ply 6 ply	...	6 ply 8 ply	...	...	...	...	...	...
15	6 ply 8 ply	...	6 ply 8 ply	6 ply 10 ply	...	...	...	6 ply	...	...	...
18	...	10 ply	...	...	...	...	...	...	...	...	...

\* Sizes approved by former SAE Tractor War Emergency Committee for use by industry during the war.

Table 3 - Wide-Base Tractor Rear Tires - Recommended Practice for Future Designs

Section Diameter	24	26	28	30	34	38	42
6	2 ply	...	...	...	...	...	...
7	2 ply 4 ply	...	...	...	4 ply	...	...
8	4 ply 6 ply	...	...	...	4 ply	4 ply	...
9	4 ply 8 ply	...	...	4 ply	4 ply	4 ply	6 ply
10	4 ply	...	4 ply	4 ply	4 ply	4 ply 6 ply	...
11	4 ply 8 ply 10 ply	4 ply	4 ply	4 ply	...	4 ply 6 ply 6 ply-Cane	6 ply
12	...	4 ply 6 ply 6 ply-LP	...	6 ply	...	4 ply 6 ply 6 ply-Cane	...
13	...	6 ply 6 ply-LP	...	6 ply	...	6 ply	...
14	...	6 ply 6 ply-LP	...	6 ply	6 ply	...	...
15	...	...	...	6 ply 6 ply-Rice 8 ply	6 ply 6 ply-Rice 8 ply	...	...
18	...	10 ply	...	...	...	...	...

Note: All tires listed are to have standard farm treads except where LP (low profile), Cane or Rice treads are indicated.

of only one size per tractor model. It was a wartime emergency list and did not provide a satisfactory range of sizes for the general use of the industry in normal times.

#### Feared Too Many Sizes

"After the war, it became apparent that the number of sizes would increase rapidly and, unless an orderly pattern was established, every section diameter produced in each of the rim diameters shown might eventually be used.

"Because of the apparent need for oversizing in certain territories, it appeared that the greatest flexibility could be obtained by providing for a

full range of section diameters, but a considerable reduction in total number of sizes could be accomplished by eliminating certain rim diameters entirely, based on the fundamental requirements of the various basic types of tractors.

"Table 3 shows the sizes recommended by the Tractor Technical Committee for future design along with all the required ply ratings and special tread designs. While admittedly somewhat of a compromise, its advantages are obvious when compared to the list shown in Table 2."

In addition to Gilmer, who headed this tire simplification activity, members of the SAE Tractor Technical Committee include: C. A. Hubert, chairman, International Harvester Co.;



The new list of tractor tire sizes recommended to the Tire and Rim Association is one of the most important projects completed by the SAE Tractor Technical Committee under C. A. HUBERT, International Harvester Co., who was elected chairman several months ago when former chairman Elmer McCormick resigned to serve on the SAE Technical Board

## '47 Handbook off the Press

The 1947 SAE Handbook is off the press and is being readied for mailing to the membership. Made easier to use, this automotive engineering "bible" will include the prints of many new technical committee projects finished this past year plus a host of other standards, specifications, and recommended practices brought up-to-date.

Among additions to this 37th annual edition of the SAE Handbook will be results of projects previously described in this section of the SAE Journal, just a few of which are:

- Nomenclature and definitions of three crank-case oil types (p. 80, March, 1947, Journal);
- Hydraulic brake fluid specifications (p. 91, February, 1947, Journal);
- Involute serrated shaft standard (p. 85, November, 1946, Journal);
- Standard pipe, filler, and lubrication fittings (p. 86, November, 1946, Journal);
- General information on welding electrodes and copper and silver brazing (p. 30, July, 1946, Journal);
- Automotive steel castings specifications (p. 44, June, 1946, Journal).

Physically the 1947 SAE Handbook will incorporate several new features. It will be one-third thinner and ½ lb lighter than the 1946 edition, despite a 10% increase in the number of text pages.

The less cumbersome volume was made possible by advance provision of paper (21 tons of paper went into the publication of the 1947 edition) during the temporary easing of the paper situation last fall. The new Handbook is printed on 45-lb paper instead of the 65-lb stock used for the 1946 Handbook.

Another new feature is the continuous page numbering system for simplified use. Intended as a printing economy, the old skip-number system created some confusion and is being replaced by the straight numbering sequence.

Every SAE member receives one copy of the SAE Handbook free. The price to non-members is \$10. Members may buy additional copies for \$5.

B. F. Campbell, Harry Ferguson, Inc.; J. M. Davies, Caterpillar Tractor Co.; L. A. Gilmer, Oliver Corp.; A. W. Lavers, consulting engineer; Elmer McCormick, John Deere Tractor Co.; L. S. Pfost, Massey-Harris Co.; O. R. Schoenrock, J. I. Case Co.; W. P. Strehlow, Allis-Chalmers Mfg. Co.; B. G. Van Zee, Minneapolis-Moline Power Implement Co., and R. C. Williams, Caterpillar Tractor Co.

Rubber company consultants to the Committee on the tractor tire size program were: Robert Borland, Dominion Rubber Co., Ltd.; J. W. Boyd, Dunlop Tire & Rubber Co.; H. W. Delzell, B. F. Goodrich Co.; G. R. Donaldson, E. P. Goodrich Co. Ltd.; A. E. Grainger, Goodyear Tire & Rubber Co. Ltd.; D. R. Hornell, Massey-Harris Co., Ltd.; H. T. Humby, Firestone Tire & Rubber Co., Ltd.; E. B. Munson, Montgomery Ward & Co.; J. W. Shields, U. S. Rubber Co.; R. W. Sohl, Goodyear Tire & Rubber Co.; J. J. Wolfe, Rubber Manufacturers Association, and C. L. Zink, Firestone Tire & Rubber Co.

## Revamp Preservatives For Aircraft Parts

UP-TO-DATE specifications for aircraft parts corrosion-preventive compounds occupy top ranking in the program adopted by SAE Subcommittee S-6B at its first meeting.

Set up under Committee S-6, Packaging of Aeronautical Parts and Equipment, to shape preservative and humidity cabinet specifications to post-war needs (see p. 29 of August, 1946, SAE Journal), Subcommittee S-6B agreed to tackle first the streamlining of corrosion-preventive compounds.

First of two existing SAE specifications to be revised is AMS 3070B, Oil Corrosion-Preventive (Carburetor Slushing). According to Chairman B.



B. E. Scott, Chairman  
SAE Subcommittee S-6B

## Reprint Sections of '47 Handbook

Six easy-to-use pamphlets containing sections reprinted from the 1947 SAE Handbook are being published, as in the past, to satisfy the demand for more popular SAE standards, specifications, and recommended practices.

- **SP-30 - SAE Iron and Steel Standards and Specifications:** Includes the standard compositions of alloy steels, automotive steel castings, malleable and gray irons as well as data on hardenability tests, hardness numbers, inclusions, magnet particles, physical properties, and heat treatment. Price: members - \$1.50; non-members - \$3.00.

- **SP-31 - SAE Non-Ferrous Standards and Specifications:** Covers specifications for casting and wrought aluminums and magnesiums; bearing and bushing alloys, copper base alloys, and zinc die castings. Also contains information on sintered powder metal bearings, electro-plating processes, and heat-, corrosion-, and electric-resistant alloys. Price: members - \$1.25; non-members - \$2.50.

- **SP-32 - SAE Standards for Rubber compounds, Hoses, Brake Cups, and Brake Fluid:** Gives classifications and physical requirements for rubber compounds as well as complete standard specifications for hydraulic brake cups and for brake, coolant system, fuel and oil, and windshield hoses. The new hydraulic brake fluid specifications also are included. Price: members - \$1.00; non-members - \$2.00.

- **SP-33 - SAE Standards for Storage Batteries for Motor Vehicles:** Standard battery sizes, capacities, and ratings are supplemented by information on testing procedure and descriptions of life tests. Prices: members - \$.75; non-members - \$1.50.

- **SP-34 - SAE Standards for Lighting Equipment and Photometric Tests.** This booklet contains laboratory test specifications for various types of automotive lighting equipment together with tables of lamp bulbs and sealed beam units with their ratings. Price: members - \$.75; non-members - \$1.50.

- **SP-35 - SAE Standards for Splines and Serrations:** Given in this booklet are detailed dimensions, basic formulas, and supplementary information on the standard involute and straight side spline and involute shaft serrations. Price: members - \$1.00; non-members - \$2.00.

## Aero Industry Adopts SAE Drafting Manual

**R**EPORTS from the aeronautic industry show that the SAE Aeronautical Drafting Manual has worked its way into the industry's bloodstream.

According to the chairman of the SAE group that developed the Manual, O. E. Kirchner, American Airlines, Inc., this manual is enjoying wide usage.

A number of leading manufacturers have adopted the SAE Manual as company drafting practice. It lends itself to company usage. The Dewey decimal page-numbering system permits the addition of material to any section

without disrupting the numbering sequence. In addition, a special section of the Manual is designated for company notes and bulletins.

Several colleges have indicated a desire to use the Manual as a guide for classroom drafting.

At present the Committee is scanning the drafting scene with the thought of improving the Manual and increasing its utility to industry. Among the items under discussion are a simplified method of showing an involute curve, additional spring data, and gage standards.

At its last meeting in Richmond, Va., the Committee welcomed R. F. Boulton, Glenn L. Martin Co., as a new member.

B. E. Scott, Wright Aeronautical Corp., this specification lists many requirements that can be eliminated. As it now stands, the specification is too restrictive.

The second specification up for revision is AMS 3072, Compound, Corrosion-Preventive (Aircraft Engine). Fault found with this AMS is the reference to aircraft engine lubricant oil, without specifying a particular oil. The Subcommittee agreed to recommend to the appropriate SAE Aeronautical Material Specification group the development of specifications for two grades of oil - one for reciprocating engines and one for jet engines.

Review of Government compound specifications reveal they do not wholly meet the industry's commercial requirements. For example, AN-C-124 is not soft enough. While protective qualities of AN-C-52 are desirable, it does not have a soft enough residual protective film that can be readily removed. Its jet black coloring also is undesirable. Need also exists for a compound like AN-VV-C-576, but with better preservative and protective properties and improved fingerprint-removing or inhibiting features.

Remedial action taken by the group consists of preparation of a specification for both a soft film, corrosion-preventive compound of the hot application type (similar to AN-C-124), and one of the cold application type (equivalent to AN-C-52B).

Another item under discussion covers preservatives for handling of personal aircraft engines in plants and warehouses.

While humidity cabinets are within this group's standardization area, the membership agreed to postpone action on this phase of preservation packaging. The Coordinating Research Council is now investigating features and applications of a recently issued AN specification covering humidity cabinets.

Serving with Chairman Scott on Subcommittee S-6B are W. A. Gurnach, Curtiss-Wright Corp., Propeller Division, and D. R. Scott, Allison Division, GMC.



**C. W. DALZELL** has been appointed chief engineer of the Franklin Transformer Mfg. Co. in Minneapolis. Previously he had been manager of engineering at Heyer Industries, Inc., Belleville, N. J., and had served that company for 12 years before joining the staff of Franklin Transformer. He has also been connected with the Union Switch & Signal Co., Swissvale, Pa., and with Westinghouse Electric Corp. at East Pittsburgh.



**SHERMAN M. FAIRCHILD**, whose career in the field of aviation extends over a period of 28 years, has formed a new organization which will specialize in business analyses and forecasts with emphasis on technical development. The new organization will be known as Sherman Fairchild & Associates. He will continue his work in the Fairchild Camera & Instrument Corp. and in Fairchild Aerial Surveys, Inc.



**DEAN HAMMOND** was recently appointed chief engineer at the Willow Run automobile plant of Kaiser-Frazer Corp. He is considered one of America's top experts in private airplane design and pioneered in the introduction of tricycle landing gear for American airplanes. He had been engineering consultant in the use of light metal alloys in automobiles at Willow Run.

**ERNEST R. BREECH**, Ford's executive vice-president—and a member of SAE's Finance Committee—is subject of a "business biography" feature article in April 1 issue of "Forbes."

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## FOR BRILLIANT ACHIEVEMENT



**LESTER M. GOLDSMITH**, chief engineer of the Atlantic Refining Co., receives the exceptional civilian service award from Lt.-Gen. R. A. Wheeler in Washington for his contributions to the laying of an oil pipeline, operation "Pluto," under the English Channel prior to the Normandy invasion. This is the highest honor the War Department can confer upon a civilian

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Seven new members have accepted appointment on the Non-Scheduled Flying Advisory Committee, **T. P. WRIGHT**, administrator of Civil Aeronautics, announced recently. SAE members in this group are **OLIVER PARKS**, head of Parks Air College, East St. Louis, Ill., and **DICK DEPEW** of Connecticut, who is one of America's earliest private fliers. **FRED WEICK**, of the Engineering Research

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**E. F. LOWE**, left, now West Coast District Manager of the Permafuse Corp., Brooklyn, N. Y., with **EDWARD W. RENTZ, JR.**, who succeeded Lowe as manager of the SAE West Coast Branch Office. President of Permafuse, manufacturers of equipment and bonding tape for fusing brake lining to brake shoes, is **S. G. TILDEN**, who, like Lowe, is a past-chairman of SAE's Metropolitan Section



**R. TOM SAWYER**, American Locomotive Co. engineer who is widely known as an author and speaker on practical and theoretical design and application of all types of motive power, has been appointed manager of the company's research Department. His offices will continue to be in New York City.

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# SAE Fathers and Sons . . . . .



SAE Past-President **HARRY T. WOOLSON**, above, and his son **L. IRVING**, who is serving the Detroit Section Governing Board as vice-chairman of Passenger Car Activity. Retiring recently from a long career culminating in his service as executive engineer of Chrysler Corp., the elder Woolson was SAE president in 1937. His son is factory manager of the DeSoto Division of Chrysler Corp.

If any SAE reader knows of any SAE Father-and-Son combinations both of whom are members of the Society, your editors would appreciate hearing from you. Several SAE members have two Member-Sons.

We will write for photographs. Informal pictures of such combinations are preferred to individual formal portraits.

Your cooperation will be deeply appreciated—we don't want to miss any SAE Father and Son grouping.



**READ LARSON**, an SAE Enrolled Student at Yale University, with his father, **C. M. LARSON**, chief consulting engineer, Sinclair Refining Co. "Cliff" has been active on the Metropolitan Section Governing Board, and on several SAE technical committees. He joined the Society in 1920.



**ELLIS W. TEMPLIN** (left) and his son **ROBERT A.** are probably cooking up a rocket-propelled truck. Ellis, 1944 SAE vice-president for T & M Activity, joined the Society in 1918. He was assistant chief engineer of Selden Motor Vehicle Co., and later was with Goodyear on Army truck projects in World War I. He is automotive engineer with the Department of Water & Power, Los Angeles. His son, who joined in 1944, is production engineer, Aerojet Engineering Co., and is active in Southern California Section work.



**LOYD A. CUMMINGS**, who had been chief engineer of the Marlin-Stockwell Corp., Jamestown, N. Y., has been appointed vice-president and works manager in charge of the corporation's plants at Jamestown and Plainville, Conn., and **DANIEL GURNEY** has been appointed vice-president and chief engineer. He was formerly assistant chief engineer.

Now affiliated with the Ashland Oil Refining Co., Ashland, Ky., **GEORGE KIRKWOOD** was with the Pennsylvania Refining Co. in Karns City, Pa.

**S. BERTRAND BARNARD**, 29-28 East Ave., Long Island City 1, N. Y., has announced his registration to practice before the U. S. Patent Office.

**SAM A. MALTHANER**, who is now chief engineer of the Automotive Division at the Gunito Foundries Corp., Rockford, Ill., was formerly an engineer in charge of wheels and drums at the Clark Equipment Co., Buchanan, Mich. In the past years he has been connected with the Erie Malleable Iron Co. and the Urlick Foundry Co., both in Erie, Pa.

**FELIX EDGAR WORMSER** has resigned as secretary and treasurer of the Lead Industries Association to accept an appointment as assistant to the president of the St. Joseph Lead Co.

**W. L. COLLINS** has been appointed manager of the Bendix-Westinghouse Automotive Air Brake Co.'s western region with headquarters in Chicago. He had formerly been an assistant manager. **J. V. RALSTON** became manager of the mid-western region with offices in Detroit, and **A. E. WOLFE**, who for the past year and a half has been personally identified with the installation of these offices, will establish his headquarters in Kyria, Ohio, where he will manage the company's central region. Ralston had been an assistant manager in Detroit.

**COL. HARRY AUBREY TOULMIN**, attorney, executive, and engineer with offices in Dayton, Cincinnati, Springfield, Ohio and Washington, has been elected chairman of the board of directors of the Tucker Corp. in Chicago.

**JACK FRYE**, former president of Trans World Airline, was recently elected chairman of the board of the General Aniline & Film Corp. and its sales agent, the General Dyestuff Corp.

**HENRY DAHLQUIST**, senior member of the firm Dahlquist & Brengle, manufacturers representatives, will sail on the Gripsholm in June for an extended visit to Sweden, Norway, Denmark, England and France, to investigate market possibilities for some of the principals represented by the firm and to contact firms desiring representation in this country.

**J. GEORGE OETZEL**, executive engineer of Warner Electric Brake Mfg. Co., Beloit, Wis., has been invited to address fleet supervisor courses at Iowa State College, Ames, and at University of Wisconsin, Madison, on electrical energy dissipators to supplement wheel brakes, May 1 and 6, respectively. He was the author of a paper presented before the SAE 1947 Annual Meeting on this subject.

**DOYLE D. BUTTOLPH** recently became manager of the Mechanical Equipment Division of Phillips Petroleum Co., Bartlesville, Okla. He joined the Phillips Petroleum Co. in 1940, was granted a military leave of absence in 1942 and served in the army for almost four years. Upon his return to Phillips he became assistant manager of the Engineering & Equipment Division of the Chemical Products Department.

**BYROM J. SMITH, JR.** has recently been made vice-president in charge of engineering and manufacturing at the Edward Ermold Co. in New York City. Prior to this he was an associate with the management consulting firm of Rogers & Slade. He has also held important engineering positions with Fairbanks, Morse & Co., Allison Division, General Motors Corp., and other midwestern manufacturing concerns.



## O B I T U A R I E S

### TOM O. DUGGAN

Tom O. Duggan, former vice-president of Thompson Products, Inc. and a widely known authority on replacement parts marketing, died March 20 at his home in Orange, Calif. He was 52, and had been with Thompson Products in Cleveland since 1931. Last June he resigned his post to live in California, where he had started a notable career in the automotive after-market 33 years ago. Recently he became a partner in the replacement parts distributing firm of Hockaday & Phillips, Inc., in Santa Ana.

Duggan was merchandising director of the National Standard Parts Association before he joined Thompson Products in the same capacity. He was made general manager of the company's service division in 1936, and vice-president in 1942.

A colorful personality, born in Denver, Colo., he was at one time an automobile race driver and an early aviation flyer. During World War I he was an army test pilot at Langley Field, Va. In the last war, on leave from Thompson Products, he served the U. S. armed forces in the European war zone as an automotive parts expert, when he set up a system for speeding the flow of replacement parts for the army's mechanized equipment. He received a government citation for this work.

### DANIEL A. MARSHALL, JR.

Daniel A. Marshall, Jr., 32, a Detroit Section member, passed away on March 21 after a short illness.

He studied two years at Vanderbilt University, and then joined the Tennessee Valley Authority as a layout draftsman. In 1940 he was employed at the Lycoming Division of Aviation Corp. in Williamsport, Pa. as a layout man and checker, and in 1943 he was with the Chrysler Corp. in the same capacity.

Marshall joined the Aircraft Engine Division of Packard Motor Car Co. in 1944 as a designer and at the time of his death was liaison engineer.

### CARLOS M. GADDA

Carlos M. Gadda died in November, 1946, as a result of an accident in Bridgeport, Conn., while testing a helicopter there. He was an aeronautical engineer with the Navy Department in Buenos Aires, Argentina, where he was a citizen.

At one time Gadda was a lieutenant engineer in charge of all engineering activities in connection with Naval Aviation for the Argentine Navy. He was also in the Royal Air Force as a student and later as an engineer.

Gadda was a member of the SAE since 1937 and was 42 years old.

# Henry Ford, SAE Founder-member Won World-Wide Fame as an Industrialist

**E**ND of an industrial epoch, and epic, too, came near midnight on April 7 with the death of Henry Ford, last of the little group of pioneers who were the first officers when the SAE was founded in 1905.

For the first four years of the Society's history, Ford served as first vice-president. And he lived to see the SAE expand its interests to serve the technical needs of a membership of more than 15,000 which today circles the world.

Founding his company in 1903 with \$28,000 borrowed from friends and trusting neighbors, he lived through tribulations and triumphs, always in control of the vast industrial empire of his own making. His name has long been used throughout civilization as a synonym for mass production—a technique which has changed the economic status of mankind.

Throughout the years Ford had been a firm supporter of the expanding SAE technical program. He served as honorary chairman of the SAE World Automotive Congress in 1939, and showed great interest in that event, calculated to broaden the frontiers of automotive engineering development.

His son, the late Edsel, and two grandsons, Henry II and Benson, were elected to membership in the Society. Many of the SAE war projects rested heavily upon Ford Motor Co.'s executives and engineers.

In his 84th year, Ford died within a few miles of the farmstead where he was born. He had been reported in excellent health only a week before, when he had returned from his winter vacation at his Georgia estate. Late in 1945 he turned the manage-

ment of the company to Henry Ford II, who had relied upon his grandfather's sage advice in reorganizing the huge business from top management down.

In his 42-year automotive career, Ford's life outplotted Horatio Alger's best. Often praised and again blamed by press and pulpit for his actions or pronouncements, he was the living exemplification of rugged individualism. His faith in simpler mechanisms, quicker ways to make things, as well as his belief in the simpler way of life, was unbounded.

The Michigan farm boy, whose industrial career began when he was past his fortieth year, saw 30,337,509 Fords roll off production lines in this country, Canada, and abroad. His faith in the future of the automobile was first disclosed in 1892 with a 4-hp experimental car, mounted on bicycle wheels.

First user of many higher strength steel alloys in the industry, first in producing complex castings in mass production quantities, and early to lay out foundry, machine shop, and sub-assembly lines as tributaries to the main assembly line, Ford's ideas and methods were copied copiously by many other industries.

"In line" ship building was inaugurated by him during World War I when one of his contracts called for speedy building of Eagle boats. Including the first all-metal airplane, his "firsts" were legion.

Again and again he made page one in newspapers the world over, as he did when he established \$5.00 an eight-hour day as a minimum in his plants, as compared with an average of \$2.40 in his company early in 1914. Many of

his theories on international policies and domestic economics were loudly condemned by many, upheld vigorously by others.

The Society was represented at Ford's funeral by Col. H. W. Alden, who, with the deceased, was a founder of SAE, and who was elected twice president.

## ROBERT H. CLARK

An authority on automotive transportation, Robert H. Clark, successively vice-chairman for T & M, treasurer, vice-chairman, and chairman of Metropolitan Section, died March 22 in his home in Wilton, Conn. He was 45 years old.

After his graduation in 1923 he made a study of automotive equipment for the Consolidated Gas Co., worked briefly for several vehicle manufacturers, and then joined the Consolidated Edison System as assistant engineer for the gas company.

He became general superintendent of transportation of Consolidated in 1940, held a number of other important administrative posts in the company during the war emergency, and again assumed that position soon after V-E Day.

He was active in affairs of Metropolitan Section for more than six years, serving as chairman during the Section year 1944-45.

A member of the Wilton Board of Education, Clark served on that community's War Price and Rationing Board, was board chairman of the Greenwich Presbyterian Church of New York. He was a member of Delta Kappa Epsilon and of the Amherst Club of New York.

## CHARLES A. ERICKSON

Charles A. Erickson, a member of the SAE since 1910, passed away suddenly on March 15. He was, until his death, employed as a sales engineer for the United Specialties Co., and had made his headquarters at the Detroit office of that company. He was 69.

"Charlie," as he was known among his friends, was a pioneer in the automotive and tractor industries. He came to this country from Sweden, at about the turn of the century. His first employment in this country took him to the Electric Vehicle Co., Hartford, Conn. Then he joined the engineering staff of the Lozier Motor Co. in Plattsburgh, N. Y., which moved to Detroit in 1910. In 1911 he became chief engineer for the Scripps-Booth Motor Co. and remained with them for a number of years until he went into business for himself. His next association was with the A-C Spark Plug Co., where he became Chicago sales engineer and completed 12 years of service. For the 10 years prior to his death, he had been employed by the United Specialties Co.



SAE Founder Member Henry Ford, with his grandson, Henry II left, directing head of the vast Ford Motor Co. enterprises, and his late son, Edsel. (This photograph was taken in 1940, when Henry Ford II joined SAE and completed the first three-generation family group in the Society)



# News..

## ..OF THE SOCIETY

### Three New Student Charters Are Granted

**C**HARTERS have been granted by Council to SAE Student Branches at two California and one Michigan engineering schools, by action taken April 11. They are:

San Diego State College SAE Student Branch, Northrop Aeronautical Institute SAE Student Branch, Hawthorne, and Lawrence Institute of Technology SAE Student Branch at Highland Park, Mich.

SAE Student Committee Chairman R. B. Sneed, in recommending favorable action on the petitions of the heretofore informal student clubs at these institutions, reported that SAE Enrolled Students have held numerous valuable meetings and believed that charters should be granted them.

Officers of the San Diego State College SAE Student Branch are: Alfred S. Sigmund, chairman; Harley L. Hyde, vice-chairman; Walter Lowe, secretary, and William H. Adam, Jr., treasurer. Prof. F. W. Schott serves as faculty adviser.

Key men at the new Northrop SAE Student Branch are: Charles H. Swan, chairman; William E. Kell, vice-chairman; D. E. Reeder, secretary, and Walter R. Davis, treasurer. Mr. M. V. Christman is the faculty adviser.

Leading the SAE student activity on the campus of Lawrence Institute of Technology are: Albert Nash, chairman; Harold Penn, vice-chairman; William F. Dow, secretary-treasurer. Faculty adviser is Dr. G. P. Brewington.

Local SAE Sections, many of which have appointed Student Activity vice-chairmen, cooperate with Student Branches by providing speakers on engineering topics, arranging for student paper contests, and sponsoring debates on engineering subjects between SAE Enrolled Student teams.

With this action there are now 20 SAE Student Branches, a sharp revival since the cessation of hostilities during which Army and Navy educational programs precluded many SAE campus activities.

### Maui Vice-Chairman

**T**HE SAE Hawaii Section has created the post of vice-chairman for the Island of Maui. (Maui is about 65 miles off the south westerly coast of Oahu Island, on which Honolulu is situated.)

Hollis Hardy has been named to the new post.

Recently a group of Honolulu members flew to that island and met with

members interested in holding meetings as a division of the Section.

Last fall the Hilo Division of the Hawaii Section was formed on the Island of Hawaii, the largest of the archipelago. Howard Overman, branch manager of A. F. Stubenberg, heads the Hilo Division. This Division has been holding regular meetings since it was formed.

### Fink Heads Aero Meeting Plans

**C**OUNCIL approved the appointment of Frank W. Fink, chief division engineer of Consolidated Vultee Aircraft Corp., San Diego, as general chairman turn to p. 107

### CRC Annual Financial Statement

**T**HE following is from the audited financial statement for the year ending December 31, 1946, of the Coordinating Research Council, Inc., in which the SAE and the American Petroleum Institute each have a half interest:

	Assets		Total
	General Fund	Restricted Fund	
Cash	\$61,152	\$63,643	\$124,795
Contributions Receivable		4,000	4,000
Travel Advance Fund	150	60	210
<b>Total</b>	<b>\$61,302</b>	<b>\$67,703</b>	<b>\$129,005</b>
	Liabilities & Reserves		
N. Y. City Sales Tax	\$ 2		\$ 2
Contributions Applicable to 1947	8,750		8,750
Reserves	52,550	\$67,703	120,253
<b>Total</b>	<b>\$61,302</b>	<b>\$67,703</b>	<b>\$129,005</b>
Note - Not shown above are current accounts and inventories amounting to \$2,938 of net assets.			
Operating Statement, CRC			
Income	\$78,570		
Expense (net)	89,424		
<b>Excess of Expenses over Income</b>	<b>\$10,854</b>		



# SUMMER

## French Lick Springs Hotel

French Lick, Ind.

### ■ MONDAY, JUNE 2

#### Transportation and Maintenance 9:30 a. m.

J. R. North, Chairman

Utilization of Chassis Dynamometers and Maintenance Record Analysis to Improve Operating Economy

- E. J. Gay and H. T. Mueller, Ethyl Corp.

Prepared Discussion

#### Materials 1:30 p. m.

C. J. Tobin, Chairman

Proper Use of Spring Materials

- F. P. Zimmerli, Barnes-Gibson-Raymond Div., Associated Spring Corp.

Corrosion Resistant Metals for Valves and Seats on Heavy Duty Engines

- A. T. Colwell, Thompson Products, Inc.

#### Transportation and Maintenance 3:45 p. m.

E. P. Gohn, Chairman

Air Brake Designing to Reduce Failures and Speed Up Action

- Julius Gaussoin, Silver Eagle Co.

Prepared Discussion

#### Body 8:30 p. m.

J. W. Greig, Chairman

What Is Automobile Design for the Future

#### A Science?

- Virgil Exner, Studebaker Corp.

#### An Art?

- Kenneth A. Hopkins, The George W. Walker Organization

### ■ TUESDAY, JUNE 3

#### Truck and Bus 9:30 a.m.

M. C. Horine, Chairman

Thermodynamics of Vapor Powerplants for Motor Vehicles

- E. B. Neil, Consulting Engineer

Prepared Discussion

#### Body 1:30 p. m.

K. E. Coppock, Chairman

Seating and Other Aspects of the Driver's Environment

- A. E. Neyhart, Pennsylvania State College

#### Materials 3:45 p. m.

T. L. Hibbard, Chairman

Designing and Building the Reinforced Plastic Automobile

- L. A. Werner, Engineering Consultant

Automotive Trim Materials

- V. J. Fisher, Fisher Body Div., GMC

#### Passenger Car 8:30 p. m.

W. S. James, Chairman

SYMPOSIUM ON AUTOMATIC TRANSMISSION COMPONENTS

#### Clutches for Automatic Transmissions

- Harold Nutt and R. L. Smirl, Borg & Beck Div., Borg Warner Corp.

#### Fluid Couplings for Passenger Cars

- A. E. Kimberly, Chrysler Corp. Automatic Transmission Control Systems

- O. K. Kelley and M. S. Rosenberger, General Motors Corp.

### ■ WEDNESDAY, JUNE 4

#### Passenger Car 9:00 a. m.

G. B. Allen, Chairman

Design Factors for High Duty Gearing

- J. O. Almen, Research Laboratories Div., General Motors Corp.

#### Truck and Bus 11:15 a. m.

F. B. Lautzenhiser, Chairman

Rubber-Tired Hauling Equipment

#### Field Day 2:30 p. m.

More Fun! More Games! More Prizes! Sam Dickey will again direct Operation Field Day with new stunts and surprises.

**COME OUT AND PLAY  
YOUR CARES AWAY**

We'll be looking for you.

# R MEETING

## JUNE 1-6

for Off-the-Highway Service

- H. L. Rittenhouse, Euclid Road Machinery Co.  
Prepared Discussion

**Business Session** 8:15 p. m.  
**General** 8:30 p. m.

R. E. Wilson, Chairman

Fuels and Engines for Higher Efficiency

- C. F. Kettering, Research Laboratories Div., General Motors Corp.

### ■ THURSDAY, JUNE 5

**Fuels and Lubricants** 9:30 a. m.  
J. R. Sabina, Chairman

#### SLUDGE SYMPOSIUM - PART I

Effect of Fuel on Engine Varnish and Sludge (Report of Engine Varnish and Sludge Group, MFD, CFR)

- W. J. Backoff, Pure Oil Co.  
Field Testing of Motor Oil and Gasoline

- A. C. Pilger, Tide Water Associated Oil Co.

**Air Transport** 1:30 p. m.

L. G. Fritz, Chairman

Should Freight and Mail Be a Separate Operation from Passengers?

- C. P. Graddick, United Air Lines, Inc.  
Some Technical Aspects of Passenger Handling

- R. W. King, American Airlines, Inc.

**Fuels and Lubricants** 3:45 p. m.  
S. W. Sparrow, Chairman

#### SLUDGE SYMPOSIUM - PART II

Investigation of Factors Affecting Formation of Low Temperature Engine Deposits

- E. J. Bowhay and E. F. Koenig, Texas Co.

The Effect of Lubricating Oil on Engine Cleanliness

- F. C. Burk, C. H. Van Hartesveldt, and J. C. Geniesse, Atlantic Refining Co.

**Aircraft Powerplant** 8:30 p.m.  
F. W. Godsey, Chairman

Preliminary Performance Analysis of Gas Turbine Powerplants for Aircraft

- I. H. Driggs, Bureau of Aeronautics, Navy Dept.

An Analysis of Composite-Powered Aircraft

- B. T. Salmon, Ryan Aeronautical Corp.

### ■ FRIDAY, JUNE 6

**Diesel Engine** 9:30 a. m.  
W. G. Ainsley, Chairman

#### SYMPOSIUM ON CYLINDER WEAR

Piston Rings

- K. H. Effmann, Perfect Circle Co.

Engine Operation

- L. A. Blanc, Caterpillar Tractor Co.

Lubricating Oil

- B. M. Berry, California Research Corp.

Fuel

- A. J. Blackwood, Standard Oil Development Co.

Instrumentation

- N. C. Penfold, Armour Research Foundation

**Aircraft Powerplant** 1:30 p. m.  
F. C. Mock, Chairman

Flame Propagation Rates at Reduced Pressures

- W. C. Johnston, Westinghouse Electric Co.

Fuels for Rocket and Jet Powerplants

- E. L. Klein, Bureau of Aeronautics, Navy Dept.

**Diesel Engine** 3:45 p. m.  
L. C. Lichty, Chairman

#### UNUSUAL ENGINES

Fuel Injection Engine with Spark Ignition

- A. M. Starr, Consulting Engineer

Prepared Discussion by:

- A. W. Pope, Jr., Waukesha Motor Co.

Slant Mechanism - Its Fundamentals and Application to Diesels for Aircraft and Other Low Weight Fields

- T. L. Sherman, Steel Products Engineering Co.

Prepared Discussion by:

- E. S. Hall, Consulting Engineer

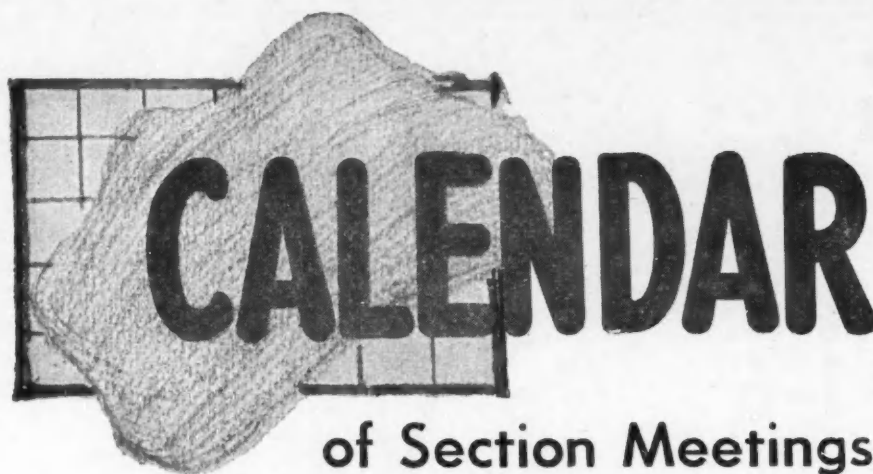
### ■ SUNDAY, JUNE 1 . . . 7:00 P. M.

## FAMILY ALBUM PARTY

A real family get-together in a Gay Nineties atmosphere. Group singing. SAE Section Barber Shop Quartet competition. Prizes.

FURBER MARSHALL, Master of Ceremonies

Tonsorially, Chord-ially and Sing-cerely you'll have a grand evening.



# CALENDAR

## of Section Meetings

### Baltimore - May 8

Engineers Club; dinner 7:00 p.m. Speaker and subject to be announced.

### British Columbia Group - May 14

Hotel Georgia, Vancouver; dinner 7:00 p.m. Trends in Automotive Lubrication - C. E. Tilston, Imperial Oil, Ltd.

### Chicago - May 13

Hotel Knickerbocker, Chicago; dinner 6:45 p.m. meeting 8:00 p.m. Current Developments in Automotive Gear Lubricants - William B. Bassett, technical representative, Lubrizol Corp. Social half-hour - 6:15 to 6:45 p.m. (before dinner) sponsored by Standard Oil Co. of Indiana.

### Cincinnati - May 12

Hotel Alms; dinner 6:30 p.m. Superchargers on Diesel Engines, - Kurt A. Beier, chief engineer, Schwitzer-Cummins, Indianapolis.

### Cleveland - May 12

Nela Park; dinner 6:30 p.m. Nuclear Energy to Power Generation - Harry A. Winnie, vice-president, General Electric Co., Schenectady. Motion picture Bikini. Closed meeting for members only.

### Detroit - May 6 and 19

May 6 - Horace H. Rackham Educational Memorial Building; dinner 6:45 p.m. A New Approach to the Flight Problem - William Stout

May 19 - Horace H. Rackham Educational Memorial Building; dinner 6:30 p.m. Dinner Speaker - C. E. Frudden, consulting engineer, Tractor Division, Allis-Chalmers Mfg. Co., and president, SAE. Subject - Ingenuity in Engineering. The Young Engineer and His Future - J. C. Zeder, chairman, Engineering Board, Chrysler Corp. Trends Influencing Automotive Design - Dr. Franklin R. Cawl, Kudner Agency.

### Indiana - May 22

Hotel Antlers, Indianapolis; dinner 7:00 p.m. Odd Problems at High Speeds - Reid A. Railton.

### Kansas City - May 20

Hotel Continental; dinner 6:30 p.m. Speaker and subject to be announced. Film.

### Metropolitan - May 14

Hotel Pennsylvania; 7:45 p.m. The Know How of Selecting the Correct Vehicle for Your Operation. Speakers - J. M. Adelizzi, R. B. George, J. J. Powelson, M. V. Department, Standard Oil Co. of N. J., T. L. Preble, Supervisor, Auto Transportation Tide Water Associated Oil Co., F. R. Nail, Assistant to chief engineer, Mack Mfg. Corp., Austin M. Wolf, Consulting Engineer.

### Milwaukee - May 2

Trip through Nash Motors Plant, Kenosha, 2:00 p.m. Technical meeting, 6:30 p.m., Dania Hall. What's the Matter With Cast Iron - A. A. Weidman, director of quality and inspection, Detroit Diesel Engine Division, GMC.

### Mohawk-Hudson Group - May 20

Hotel Van Curler, Schenectady; Mobile Communication Equipment - Carl F. Meyer, design engineer, Radio Section, Transmitter Division, Electronic Department, General Electric Co. Exhibit and road demonstration of some of the latest equipment.

### Northwest - May 2

Hotel Gowman; dinner 7:00 p.m. Speaker and subject to be announced. Motion picture by Cleveland Graphite Bronze Co., Bearings. Slides by Perfect Circle Co., Proper Installation Procedure of Piston Rings and The High Power Inch.

### Northern California - May 13

Engineers Club, San Francisco; din-

ner 6:15 p.m. The Turbocharged Diesel Locomotive - R. Tom Sawyer, Manager, Research Department, American Locomotive Co.

### Oregon - May 16

Oregon State College. Tour through College Motor and Engineering Laboratories. Buffet supper. Speakers and subjects to be announced.

### Peoria - May 12

Hotel Jefferson; dinner 6:15 p.m. The Relation Between Metallurgy, Engineering and Material Specifications - F. G. Tatnall, Baldwin Locomotive Works. Joint meeting with American Society for Metals.

### Philadelphia - May 14

Engineers Club; dinner-dance beginning at 6:30 p.m. Annual ladies night. Sound, color motion pictures.

### St. Louis - May 13

Hotel De Soto; dinner 6:30 p.m. meeting 8:00 p.m. Application of Diesel Engines to Locomotives - G. L. Bader, chief engineer, Busch-Sulzer Bros. Diesel Engine Co., Division of Nordberg Mfg. Co.

### San Diego - May 7 and 22

May 7 - San Diego Women's Club, San Diego; Meeting at 7:30 p.m. followed by buffet supper. Development of Engineering School at San Diego State College - Prof. O. H. Baird; What Every Young Engineer Should Know - Edmund Price, president of Solar Aircraft and president of San Diego Chamber of Commerce. Joint meeting with Student Group at San Diego State College.

May 22 - San Diego Womans Club, San Diego; dinner 6:30 p.m. Speaker and subject to be announced. Joint meeting with local section of Institute of Aeronautical Sciences.

### Southern California - May 8

Hotel Biltmore, Los Angeles; meeting 8 p.m. Aircraft meeting. Chairman - Carl Stryker Prerotation of Landing Wheel - Edward R. Warner, project engineer, Lockheed Aircraft Corp.

### Southern New England - May 16

Wethersfield Country Club, near Hartford, Conn.; dinner 7:00 p.m. Annual spring outing. Motion pictures and entertainment after dinner.

### Washington - May 13

Hotel Twenty-Four Hundred; dinner 6:30 p.m. European Highway Transportation - H. H. Kelly, regional director for North America, European Central Inland Transport Organization. Color slides.

## SAE NATIONAL MEETINGS

MEETING	DATE	HOTEL
PERSONAL AIRCRAFT	May 1-2	The Lassen Wichita
SUMMER	June 1-6	French Lick Springs French Lick, Ind.
WEST COAST T&M	Aug. 21-22	Biltmore Los Angeles
TRACTOR	Sept. 17-18	Schroeder Milwaukee
AERONAUTIC (Autumn)	Oct. 2-4	Biltmore Los Angeles
PRODUCTION	Oct. 20-21	Carter Cleveland
FUELS & LUBRICANTS	Nov. 6-7	The Mayo Tulsa
AIR TRANSPORT	Dec. 1-3	Continental Kansas City, Mo.
ANNUAL	Jan. 12-16 (1948)	Book-Cadillac Detroit

## FLASH!

PREPRINTS—Complete with photographs—  
To Be Sold at Meetings

Two innovations concerning preprints of National Meeting papers will be introduced at the 1947 Summer Meeting, according to action of SAE Council at its April 11 meeting, upon recommendation of the SAE Finance Committee and of the Meetings, Publication and Membership Committee chairmen:

- Preprints of SAE papers will be *complete*, reproducing for the first time all material submitted by the authors, including photographs
- To eliminate the waste unavoidable in giving papers away and to provide revenue to defray the increased costs of complete packages, preprints will be sold at SAE National Meetings at a nominal price

## Student Branch News

Massachusetts Institute of Technology

M.I.T. student members heard an exhaustive survey of powder metallurgy from its use by Egyptians and Pre-Columbian Indians to its future potentialities. Prof. John Wulff of M.I.T.'s Department of Metallurgy was speaker at this Feb. 27 meeting.

Concept of powder metallurgy, he said, evolved because there were no furnaces capable of producing high enough temperatures to melt common metals, so that conventional molding methods were impossible.

First real advance in the science came in the eighteenth century, when it was discovered that platinum powder would fuse at relatively low temperature in the presence of arsenic. The arsenic then could be volatilized by prolonged heating, leaving pure platinum easily forgeable into shape. Similar results soon were attained with mercury or sulfur, and the principle made it possible to form, at relatively low temperatures, metals with extremely high melting points.

The electronics industry provided great stimulus for further study and development in the search for a metallic filament for the Edison lamp. Today the powder process produces all tungsten filaments.

Powder metallurgy is the only means, Wulff pointed out, for controlling rigidly the permeability of metals: thus its wide application in the manufacture of self-lubricating bearings. In their production, tin and copper powders are mixed thoroughly with lead and graphite, pressed to shape and sintered. The graphite gives excellent lubrication properties, and the metal is porous enough to permit the injection of 2 to 3% of oil. This built-in lubrication usually will last the life of the bearings, although the capillary attraction of the interconnecting pores may be used to draw additional oil from reservoirs in contact with the outside walls of the bearing.

Another important present-day application of powder metallurgy is in the manufacture of high-hardness cutting tools, and in the handling of refractory metals such as tungsten, tantalum, and molybdenum, which, because of their high melting points, are difficult to work by ordinary methods. Tungsten carbide, because its high melting point of 3600 C enables it to retain a sharp edge at high temperatures, is an excellent tool and is widely used to cut all metals except steel. Tungsten titanium carbide, bonded with cobalt, is used to cut steel, because the metal chips will not stick to the material and crater the tool.

Other important uses of powder metallurgy, he said, are for producing metals containing evenly distributed nonmetals; forming compounds of two or more metals which do not form alloys; and reducing machining costs in the manufacture of certain products.

Chief limitations of the method are in size and shape: the product must be small and symmetrically shaped if powder methods are to be used successfully. Shape must be such that there is no back draft to prevent the piece from being withdrawn easily from the die. Metal objects made by this process have a low tensile strength and low ductility, but further developments in methods of hot coining or hot pressing may remedy this defect.

Advantages, on the other hand, are the high purity (usually over 99%) of metals obtained; accurate control of composition; and a very high production rate (as high as 500 per min on some small pieces) already reached by the industry.

#### University of Oklahoma

Uses and probable future of the diesel engine were brought out at the March 5 student branch meeting of the University of Oklahoma by E. J. Van Dyk, sales engineer for General Motors Corp. The diesel engine, Van Dyk claimed, is the most efficient and practical of all internal combustion engines. The war uncovered many new and varied uses for diesels.

George W. Cupit, Jr., secretary of SAE Mid-Continent Section, was a guest at the meeting and invited the Oklahoma University Student Branch

to the Section's Oklahoma City meeting, March 28.

University of Oklahoma student members put in a full day March 28 by touring three industrial firms in Oklahoma City and attending a Mid-Continent Section meeting in the evening.

Thirty students and six faculty members inspected Black, Sivalls & Bryson, Inc.; General Motors Diesel Power Co., and American Iron & Machine Works Co.

Black, Sivalls & Bryson manufacture oil field equipment, specializing in pressure tanks, separators, and heat exchangers. The group saw all the production stages from shaping to testing of the finished product. At American Iron & Machine Works they watched the interesting machine operations involved in making oil well drilling equipment. General Motors Diesel had arranged a special exhibit of different types of GM diesel power units, as well as parts, injectors, test equipment, and so on.

Guest speakers at the Mid-Continent Section meeting were R. G. Hillgoss, owner of the Bartlesville Bus Co., and Paul V. Gillian, chief design engineer for White Motor Co. Hillgoss spoke on "Operation Problems in Intra-City Bus Transportation," revealing results of his company's efforts to solve certain operation and maintenance problems encountered in bus operation. White has done considerable research on varnish deposits in the engine, and Gillian said their solution was to install an electric fan to force ventilation through the crankcase.

Gillian's paper on "Present and Future High-Output Gasoline Engines"

was supplemented with slides showing design features of various types of spark ignition engines. Special emphasis was on combustion chamber valve arrangements, sparkplug locations, and so on. He pointed out that although conventional sparkplug location is near the intake valve, in practice it is not always the best location. In the final analysis experimentation determines sparkplug location. One of his company's experimental engines, he said, has five sparkplugs in its cylinder.

#### City College of New York

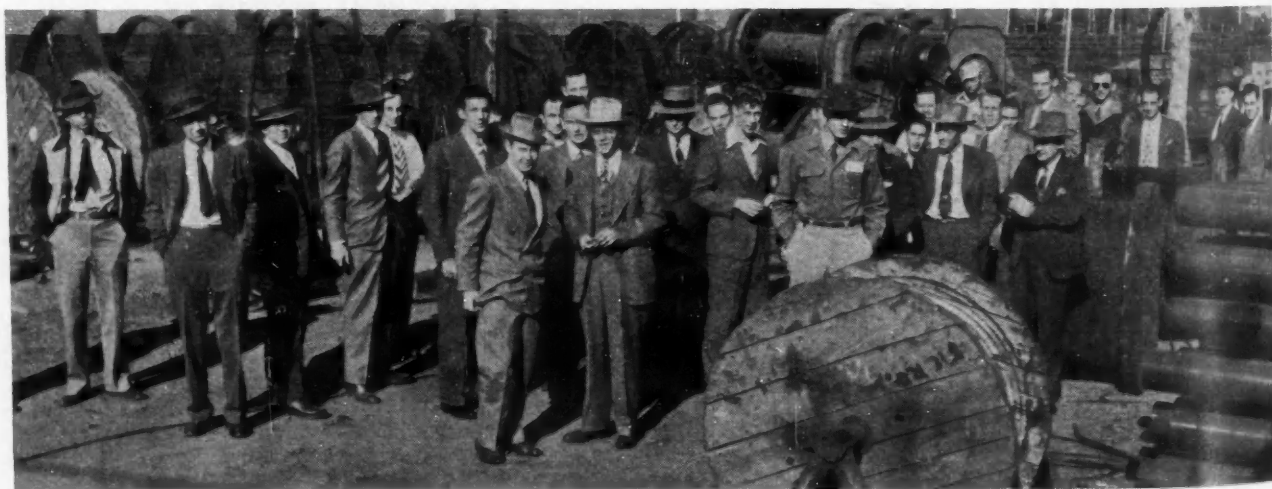
Positive-displacement rotary pumps and their use were the subject of Peter Renzo's talk before CCNY's March 5 Student Branch meeting. Renzo, of Sier-Bath Gear Co., explained that this type of pump generally is used for high viscosity liquids (from 300 SUS up) and for higher pressures, as well as for certain low viscosity liquids which would be churned to foam (as would beer) by a rotary positive displacement type.

Renzo showed charts to illustrate how efficiency increases with increasing pressures. In some pumps efficiency is as high as 80%. The use of externally driven pumps was shown to be of great advantage in pumping non-lubricating liquids.

Existing pumps, Renzo said, live only a few months under the abrasive action of paints and chocolate syrups; one that will stand up under them is badly needed.

Informality was the keynote at this session, and helped stimulate a lively discussion.

## UNIVERSITY OF OKLAHOMA STUDENTS TOUR AMERICAN IRON & MACHINE WORKS



SAE student members from University of Oklahoma are shown on one of their three plant inspections, March 28

Topic at the March 12 meeting was "Ramjets" - by popular demand. Henry Balfour, of Wright Aeronautical Corp., and editor of the Met Section "Accelerator," explained some of the difficulties encountered in supersonic flight and discussed basic principles of the ramjet engine.

Build-up of tremendous pressure areas by the movement of bodies through air at approximately the speed of sound causes unpredictable and unprecedented occurrences, he said. First problem, therefore, was the design of foils or forms to minimize these pressure areas or shock waves. Balfour's pictures of designs, although almost identical with Buck Rogers' space ships, were nevertheless characterized as obsolete. He said there is no longer a line of demarcation between engine designers and airplane designers; the two must work as a team in complete coordination at all times.

Principle of operation was explained: Air for combustion is taken in through a hole in the nose and passed through a diffuser which slows it down to subsonic speeds, and builds up the pressure. Fuel is injected and burning takes place in the combustion chamber directly behind the opening to the diffuser. The expanding gases are then driven out the back through one of two types of tail pipes or exhaust nozzles - or even none at all.

In the classical sense of combustion, it can be considered a diesel cycle.

A principal difficulty is maintaining combustion inside the combustion chamber, as velocity of the moving charge, although subsonic, is quite large compared with the time rate of fuel burning. The burning charge is blown out the exhaust before combustion is complete, leaving the chamber without a light to ignite incoming gases. Many types of flame holder now are being developed to maintain combustion in the chamber and not outside.

Most of the discussion took place during the talk, as it usually (and popularly) does at CCNY student meetings.

#### Purdue University

Student Branch members from Purdue heard R. L. Lewis describe McDonnell Aircraft Corp.'s "Phantom" - a jet-propelled, carrier-based Navy fighter, which, although it is far superior in performance to the standard propeller-driven Navy planes now used, already is obsolete. Lewis described performance characteristics of the Phantom and of high-speed aircraft in

general on March 24, at a joint meeting sponsored by local chapters of the SAE, ASME, IAS and ASCE.

Lee R. Baker, director of Chrysler Institute of Engineering's graduate school, spoke to Purdue's student branch on March 31, on "The Young Engineer in Industry." Baker pointed out some of the standards by which an employer judges a young engineer. Engineers must, he said, be equipped not only to handle technical problems but also to cooperate with others; and they must be about 40% expeditors.

He also described the organization of the Chrysler Institute and of the corporation's Engineering Department.

At this meeting Albert W. Dodd was elected chairman of the Purdue Student Branch for the remainder of the semester. Harry McCrady was appointed chairman of a newly-formed publicity and membership committee.

#### Lawrence Institute of Technology

A good engineer must have a knowledge of many diverse subjects in addition to his technical specialty. This fact was clearly illustrated to the SAE Student Branch at Lawrence Institute of Technology by Glen Howell of the Howell Engineering Co. in his address on March 24 on "What An Engineer Does."

The speaker stressed the fact that an engineer must have more than a good technical knowledge. He revealed that the average executive, when considering an engineer for a position, rates the man 30% on technical qualifications and 70% on other factors... including personality, appearance, and ability to speak and present ideas.

Using a very simple sheet metal box as an example, Howell explained how the engineer's knowledge of machine processes, materials, chemistry, transportation, handling methods, law, and labor relations affects the development of the final product. From this illustration the students obtained a much clearer insight into what an engineer's job entails.

Prior to graduation, the engineering student has, in many cases, little contact with industry. As a result, he has but a hazy conception of what his job will be after he graduates. To broaden the student's knowledge of engineering problems and methods in industry, this Student Branch of the SAE is providing the very necessary contacts between students and the engineers in industry. Howell's address is a concrete example of this type of contact. Real and useful knowledge was presented to the student through the lec-

ture - knowledge that could not have been gained through the regular school curriculum.

#### New York University

NYU's SAE Student Branch joined ASME and IAS on March 19 to make a tour of Ford Motor Co.'s Edgewater Plant. More than 75 members were present.

Dr. Stephen Zand, of Sperry Gyroscope Co., told Branch members at their March 27 meeting about problems involved in the development of the artificial horizon. He explained how the instrument was developed to satisfy an urgent need for a horizon indicator in blind flying. Zand illustrated his talk with a working model of the artificial horizon, and pointed out the many engineering challenges which had to be met in order to produce a dependable, precision instrument in quantity and at low cost.

He advised students of the frequent necessity of innovating production techniques and of seeking simpler ways of doing things. He counseled them never to be afraid of calling in outside help to solve a problem requiring specialized knowledge.

Roger Mahey, SAE director of Student Services, accompanied Zand to the meeting and answered many questions about functions of the student branch. Sixteen new members have been accepted into the branch since the last meeting.

#### Northrop Aeronautical Institute

Northrop students, as a part of their aeronautical engineering course, are designing a personal-type plane which will subsequently be built in the Institute's Mechanical Division.

The proposed plane will embody features believed most attractive to that part of the flying public still grounded by various inadequacies of private planes. Features are to include low cost, stall- and spin-proof characteristics, and increased ground safety derived from the pusher-type propeller installation enclosed between protective twin booms.

Because the two-place cabin is forward of the wing and unusually low in profile, entrance is similar to that of an automobile. The 100-hp engine and clean design, incorporating large formed windshields and fully-retracting landing gear, give a calculated top speed of 145 mph and cruising speed of 125 mph.

Among the more advanced design features proposed are the fully automatic flaps extending almost the full span of the wing. This advantage is made possible through use of spoiler ailerons, as used on the Northrop P-61 and F-15. It is believed the resultant low landing speed of 50 mph, combined with the wide tread of the tricycle gear, will produce an unusually safe and easy plane to handle.

A 25-gal tank gives a range of over 600 miles; on shorter flights, a small drop seat makes it possible to replace the 80 lb of baggage and some of the fuel load with a third person. An initial rate of climb of 800 fpm and a service ceiling of over 13,000 ft will make the NAI-1 an ideal personal plane for crosscountry flights.

The design project is headed by a project engineer and two assistants, and is being carried out in much the same manner as it would be in industry. Fuselage, wing, boom, empennage, landing gear, controls, powerplant, electrical equipment, and interior sections will each be headed by a design engineer and assistant design engineers. Group leaders within each section will have immediate supervision of the drafting and design for their particular groups.

That all phases of a new design may be more thoroughly understood, all features of the basic design become a part of the regular program. Each term the students in classes in strength of materials, airplane design, aerody-

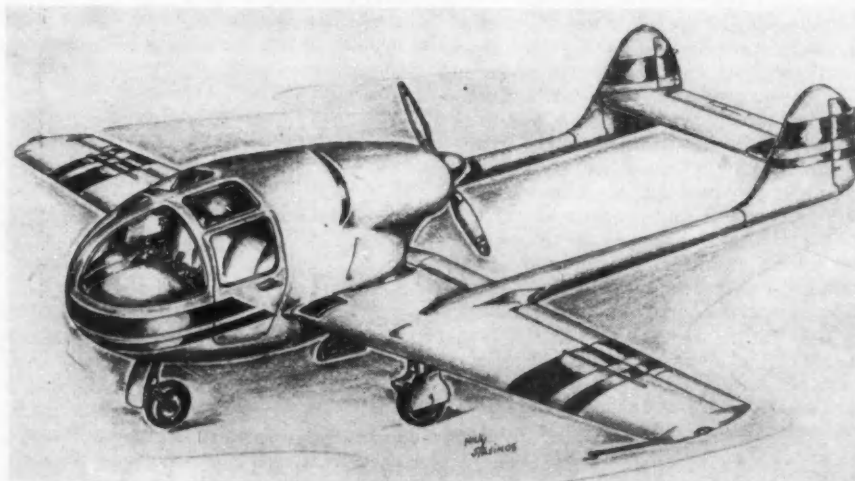
present time, a full-size mockup is being built to determine the most practical layout of interior arrangements and to provide the greatest degree of safety and comfort.

In addition to the NAI-1 project, Northrop students are designing and will build a wind tunnel. Tests of scale models of the present design, as well as other designs which will follow, will be made in this tunnel.

Practical projects of this kind make it possible for the student to receive a type of training that is immediately and vitally useful in the aircraft industry. In addition to projects carried out by groups, individuals will be required to develop an original design project or to participate in a research problem.

Biggest problem in supersonic flight at present is to provide adequate structural rigidity in the severe designs necessary to achieve supersonic speed. Herb Lawrence told the March 13 meeting of Northrop's SAE Student Branch.

Speaking on "Sweptback Wing Theory," the aerodynamicist from Northrop Aircraft Co., Inc., talked optimistically about the chances of penetrating the speed-of-sound barrier, even though present-day subsonic sweptback will not give sufficient efficiency for designs now in development; tests have shown that results probably will be better than originally expected.



The NAI-1—Artist's sketch of the new student project at Northrop Aeronautical Institute

namics, stress analysis, and so on, will carry out assignments on this design project. All necessary loft information is to be furnished by a separate group of students who are working in close harmony with school lofting classes. Another group will develop the necessary production breakdown and take care of production engineering. At the

A number of visitors attended as well as regular members.

A high percentage of Northrop Student Branch members took part March 29 in an interesting and informative tour of the Southern California Cooperative Wind Tunnel. The tour was arranged through Prof. Peter

Kyropoulos, of California Institute of Technology, who has been of valuable assistance to Northrop's newly-formed group.

Herman Miller, technician who conducted the tour, gave a traveling lecture on the tunnel's operation as the group saw various parts of it. He said pressure in the tunnel could be varied from 1/10 to 4 times atmospheric pressure, and tests could be made up to the speed of sound. True flight test conditions can be closely duplicated with models if the Mach and Reynolds Numbers are made the same as those of the proposed full-size plane.

## Bumpers

cont. from p. 72

no possible way to standardize bumper heights. Bumper heights vary from 18 to 55 in. above the ground in the front, and from 16½ to 58½ in. in the rear.

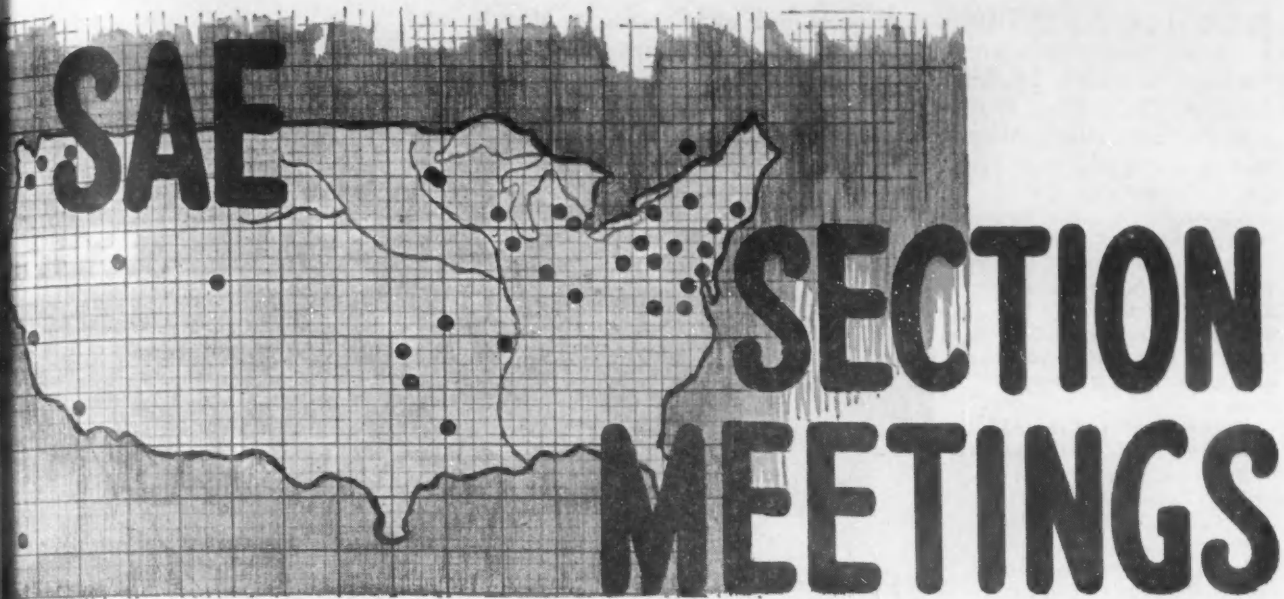
On buses, front bumper heights vary from 17½ to 39 in. and rear bumpers from 18½ to 41 in. above the ground.

Bumper heights for passenger cars and light delivery trucks were first standardized by SAE in 1922. In 1931 this standard was revised so that the horizontal center line of the bumper face, exclusive of fittings, would be 17 in. above the ground,  $\pm \frac{1}{4}$  in. per in. of effective face for rear bumpers, and  $\pm \frac{1}{8}$  in. per in. of effective face for front bumpers. These dimensions are the mean between no-load and full-load heights.

With the advent of softer springs and the adoption of bumper guards, variations in bumper heights were accentuated and the revised standard became obsolete. The urgency of World War II and its problems sidetracked until this past year any further revision of the standard.

Members of the SAE Bumper Heights Committee are: G. L. McCain, chairman, Chrysler Corp.; B. J. Anibal, Pontiac Motor Division, GMC; M. S. Bald, Hudson Motor Car Co.; W. J. Baumgartner, GMC Truck & Coach Division; W. F. Benning, Willys-Overland Motors, Inc.; R. E. Busey, White Motor Co.; M. B. Hammond, Standard Steel Spring Co.; F. F. Kishline, Nash-Kelvinator Corp.; F. B. Lautzenhiser, International Harvester Co.; D. C. Perkins, Oldsmobile Division, GMC; K. K. Probst, Reo Motors, Inc.; E. F. Reynolds, Buick Motor Division, GMC; E. G. Schubert, Ford Motor Co.; W. W. Smith, Studebaker Corp.; H. I. Sole, Packard Motor Car Co.; E. G. Sprung, Chevrolet Motor Division, GMC; W. J. Tell, Cadillac Motor Car Division, GMC, and G. W. Thomas, Kaiser-Frazer Corp.

# SAE SECTION MEETINGS



## Fleet Maintenance Schedules Reported

by GEORGE W. BAUGHMAN, Field Editor

**WICHITA Section, March 13**—Equipment, maintenance procedure and maintenance schedules of a large fleet operator were fully described at this meeting by Harold Liberty of Santa Fe Trailways. Santa Fe operates 412 buses for an average of 3,765,000 miles a year. Twelve garages are required to maintain the fleet, one capable of doing complete major overhaul.

Regular service periods are provided at 1000, 5000, 10,000, 20,000, 60,000, and 120,000 mile intervals. The 60,000-mile overhaul is classed as a major overhaul, and takes four men three days. This short down-time is made possible by the use of preassembled replacement kits. The 120,000-mile service check requires replacement of all moving parts as specified. Sleeves and pistons are replaced, and steering mechanism, wheel assemblies, engine blocks and axles are Magnaflexed. Inspection and repair schedules are closely maintained through the system.

Spirited discussion following Liberty's paper revealed the extensive differences in bus and truck regulations in interstate operation from state to state, from the standpoint both of actual rules and regulations and their administration. For example, bus license fees are \$698 in Texas . . . \$30 in Kansas.

During the war some buses operated 300,000 miles without major overhauls. Clutch maintenance is cut approximately in half by hydraulically-actuated clutches.

For safety and emergency equipment, Liberty said, each bus has four

electrically-operated fuel pumps, two batteries, spare fan and generator belts, spare spark plugs, spare condenser, distributor and wiring kits, three fire extinguishers, first aid kits, emergency escapes, and flares, flags and fuses.

## All-Over Safety Called Tucker Aim

by ARNOLD R. OKURO, Field Editor

**NEW ENGLAND Section, April 8**—Engineering aim in the new Tucker car has been to build safety into every element . . . brakes, windshields, lighting system, electrical system. So said Kenneth E. Lyman, technical adviser to the president of Tucker Corp., speaking before this Section.

Lyman emphasized the fact that

nearly every major advance in automobiles "since rubber tires were put on buggy wheels" has been brought about against determined opposition of die-hard conservatives who complain of its impracticability even after it has been proved and accepted by the public. Progress, he said, grows from the vision of men with faith in their judgment.

## Aircraft Techniques Found Useful to Buses

by J. M. LANTZ, Field Editor

**OREGON Section, March 28**—How Kenworth Motor Truck Corp. adapted the engineering techniques of the aircraft industry to peacetime bus construction was illustrated today by H. E. Simi, engineer and manager of the corporation's Bus Division.

Simi spoke on the construction of integral-type buses, and showed slides depicting jig construction and design-arrangements for employee comfort. Jigs shown were of the revolving type, handling a side or end section so that all operations can be performed without climbing or stooping. One advantage of these fabrication jigs is that highly-skilled labor is not a prime requisite.

Technical Chairman Earl B. Richardson conducted the question period, during which keen interest was shown in the adaptation of torsional bar springing as used on these buses. Simi pointed out that the leaf-type spring weighs four times as much as the torsion bar spring for an equal load. A unique development on this spring allows it to be wound up through a worm and gear arrangement so that it may be adjusted to varying load distribution and road contour.

### CLOSING DATE

SAE Journal strives, in these pages, to bring to Society members live, prompt news coverage of every Section meeting. Material is provided by Section field editors.

With dates determined by printing schedules, this issue covers all Section meeting news received in New York up to April 15.

**P**RESIDENT FRUDDEN'S travels during February, March, and April have taken him to 10 Sections and Groups . . . Peoria, Milwaukee, Western Michigan, Canadian, Buffalo, Syracuse, Mohawk-Hudson, Baltimore, Washington, and Philadelphia. He was principal speaker at Peoria, Western Michigan, Mohawk-Hudson and Washington, and gave brief talks at the other five Sections.

Although Canadian Section presented him on March 24 with an umbrella cane as assurance of fair weather on his peregrinations in the Society's behalf, Buffalo greeted him the next day with abundant snow and a 60-mph gale.

After an informal luncheon with members of Syracuse Section's Governing Board on March 26, Frudden drove to Cornell on the 27th for an interesting session with professors in the agricultural department. A good part of the day was spent in a debate on the processing of hay, in which Frudden stood off two young PhD's. It was a draw.

Albany provided some spring-like weather on March 28. Six RPI students arrived from Troy for Mohawk-Hudson Group's meeting.

At Baltimore, a Harbor Patrol launch was put at the SAE President's disposal, and he was given a 2½-hr inspection tour of the great Baltimore Harbor—where the Star Spangled Banner still waved at Fort McHenry on the night of September 12, 1814, and inspired British prisoner of war Francis Scott Key to write the immortal words which have become our national anthem. Responsible for this signal municipal honor to President Frudden was Baltimore Section Past-Chairman George E. Hull, who, with Entertainment Committee Chairman Albert L. Theobald and SAE Journal Editor Norman Shidle accompanied the president on his maritime adventure.

Washington Section presented SAE's chief executive with a transparent plastic paperweight of which his initials comprised the design, and had as honored guests to welcome the president, Past-President A. J. Scaife and

Brig.-Gen. F. S. Robillard, U. S. Marine Corps.

At all meetings, the president show-



Canadian Section's Governing Board meeting at the Granite Club, March 24. Shown at luncheon are (l. to r.) Marcus L. Brown, Jr., SAE councilor and Section past-chairman; Ed F. Armstrong, vice-chairman; President Frudden, and C. E. McTavish, Section chairman and host of the occasion

ed a film depicting the latest tractor and farm equipment designs at work.

Assembled from parts of films made available by all the leading tractor producers, the film dramatized for city audiences the ingenuity of the American farm boy (whom the president

credits with much of the inventive genius behind the new units), and gave most of his listeners their first glimpse of such startling items as cotton pickers, flame-throwing weed-killers, and corn-shuckers. Several of the pieces of equipment shown will not be on the market for another year or so.

Through his talks to the various Sections, President Frudden brought members into closer touch both with SAE's national organization and with the tractor industry of which he is a part. Because he is SAE's first tractor president, and because the tractor industry is interrelated in so many ways



Left: Principals at Philadelphia Section's April 9 meeting included (l. to r.) B. Frank Jones, technical chairman; John G. Moxey, Jr., Section chairman; President Frudden, and Merrill C. Horine, who spoke on "Current Motor Bus Development"

Right: Jones, Moxey, Frudden, Horine and SAE Journal Editor Shidle look on as Emil Gohn and O. M. "Ollie" Thornton perform. Far right: Thornton lends Gohn his good right hand while A. F. DeLong and W. R. Herfurth attempt the vocals. Thornton held informal tryouts at this meeting for a barbershop quartette to entertain the family album party at Summer Meeting



**TEN**  
Welcome  
On First Lap

# SECTIONS

## SAE President C. E. Frudden of Comprehensive Sections Tour



Washington Section Chairman Alwin A. Gloetzner, Frudden, and SAE Past-President A. J. Scaife at April 8 meeting



Section Past-Chairman P. C. Ritchie, President Frudden and Chairman C. T. O'Harrow shown at Milwaukee Section dinner meeting, March 7

with other industries represented in the Society, Frudden has made "Engineering Whys of the Modern Tractor" the theme of his Section talks.

It seems significant, he said, that 1916—when SAE changed its name and tractor engineers came into the Society—was the high point in American farm population. Since that date farm population has gradually decreased... but the nation has been better fed while total population has risen.

A large percentage of this increased productivity has resulted from the spread of tractor use on American farms. There are 4,500,000 farms large enough to support tractor use; 2,250,000 of these have tractors. By 1950, there may be 3,000,000 tractors.

Tractor dimensions are dictated by tractor needs in the cornfield: there is 18-20 in. clearance under the axles, and wheels are spaced to run between the rows. The machine is easily adaptable to other crops. Engines, too, follow a general pattern. Typical specifications include four cylinders, overhead valves, hardened exhaust valve seats and replaceable cylinder linings.

This combination of removable liners and a cylinder head containing overhead valves gives low fuel consumption performance, minimum cost of rebuilding when parts become worn. It also gives reasonably good operation on fuels in the distillate class, which often are cheaper than gasoline.

Running at full load on 70-octane gasoline, tractor engines often deliver fuel economy in the range of 0.5 lb of fuel per hp hr.

Maintenance is as simple as present technology can make it. Piston rings and cylinder walls usually have to be replaced two or three times during engine life because of dust accumulation. But a complete outfit of pistons, piston rings, pins and bushings for a 4-in. bore engine costs only \$32.64, and the farmer can do the overhaul job himself.

Tractor parts improvements cannot

stop much short of 100% efficiency. Engineers, Frudden said, are not satisfied with air cleaners 99% efficient, because under the rigors of farm operation the 1% of dust that finds its way into engine cylinders can do a lot of damage.

Of particular interest to aircraft and automobile engineers searching for materials to save weight and thus add payload was Frudden's explanation of tractor engineering's unique material needs. The tractor designer wants a low-density, low-cost-per-lb material to achieve good traction through extra weight without extra bulk.

Frudden emphasized the happy meeting of mutual interests that has been an important result of the entry of tractor engineering into SAE. The tractor provides an immense actual and potential market for tires and for fuels; and SAE standardization of rubber tires and tractor power shafts has been invaluable to the industry. As a result of this work, it is possible now

to couple any tractor of any model with almost any power-take-off-driven implement without special parts or special fitting.

Even more far-reaching than immediate benefits to the manufacturer and the farmer are the fertile possibilities standardization has uncovered for new applications of machinery to farm use.



SAE Staff Member Hollister Moore, Chairman Paul Hovgard and President Frudden about to enter the altitude chamber at Cornell Aeronautical Laboratory in Buffalo, March 25

## State Engineer Tells Of Safety Inspection

by JEAN Y. RAY, Field Editor

VIRGINIA Group, March 17—This Group took advantage of the coming resumption of Virginia's semi-annual inspection of all licensed motor vehicles to invite Capt. W. L. Groth, safety engineer of the Division of State Police, to speak to its dinner meeting.

Groth told the 173 members and guests present at the Country Club meeting that the first postwar inspection period would extend from July 1 to Aug. 31, and outlined requirements. Shortage of parts and labor during the war period, he said, have resulted in much deferred maintenance, and made it advisable to extend the usual 30-day period to two months. He urged garages and service stations to make sure that all vehicles brought in for inspection are properly prepared and repaired, pointing out that negligence on this score would result in loss of the station's permit and fining and blacklisting of the mechanic involved. He also outlined equipment a garage must have to qualify as an inspection station. Increase in highway accidents, he said, is responsible for the resumption of inspections.

J. Y. Ray, a past-chairman of Virginia Group, pointed out advantages of the state inspection from the viewpoint of fleet operators and garage owners. He said that past experience indicated that it kept mechanics on their toes and resulted in better work throughout the year. There were less frequent trips to the garage for repairs, because work was done properly when the vehicle was repaired, and maintenance costs were thus lower.

Ray took dealers and garage owners

to task for poor workmanship and questionable practices followed in most shops and garages, pointing out that they react to the detriment of the whole industry. He urged dealers and garage operators to pay more attention to treatment the customers are getting both in front and in the shop. While a customer might not complain to dealer or service manager when he is dissatisfied with treatment or work, the same customer does not hesitate to broadcast his treatment to friends or anyone else who will listen. Such broadcasting does the automotive industry no good, he said, and can build illwill that is hard to overcome.

## Turbine Expert Covers Ancient History, Future

by WARREN HASTINGS, Field Editor

CANADIAN Section, March 24—"The Gas Turbine" was the subject of a paper, illustrated with slides, by Prof. E. A. Allcut, president of Affiliated Engineering & Allied Societies, professor of mechanical engineering and chief of the Mechanical Engineering Department, University of Toronto.

There are currently enrolled at the University of Toronto some 40,000 students, and more are taking the courses of the Faculty of Applied Science and Engineering now than the total enrollment at "Varsity" at the time many members of the Section were "swatting" there. The engineering faculty is laboring under the no-mean difficulty of having its student body divided into two parts, one centered in the campus and the other occupying the structures of Ajax, midway between Toronto and Oshawa, where high explosives were

made in wartime. Student body of the University is said to be the largest of any university in the world outside the United States. What is better is that its large element of returned men has proved to be a stabilizing and energizing factor rather than a disruptive one as some cynics had pessimistically predicted.

Guest-Speaker Allcut traced the development of the turbine from the aeolipile by Hero of Alexandria, and had a large proportion of the engineers present cudgeling their brains in endeavoring to remember just what entropy and adiabatic expansion are. In addition to his description of the various types of gas turbines, Allcut referred to the potentialities of pulverized coal turbines. He gave it as his opinion that the axial type of gas turbine will supersede the radial type, and that the turbine in its present state of development is no threat to the conventional internal combustion engine as the power unit of road vehicles.

Among much else of interest, he stated that the Rolls-Royce Derwent V burns over 150 tons of air per hr, a consumption of nearly 4,000,000 cu ft of air every 60 min.

## Graphite Question Sparks Long Argument

by C. K. TAYLOR, Field Editor

INDIANA Section, March 13—Vivid discussion followed presentation of Paul Klotsch's Annual Meeting paper on "Copper-Braced Crosley Motors" at this meeting. Unusually long discussion was tipped off by the question:

"Is it necessary to use a premium gasoline or oil?"

Klotsch answered that it is not necessary to have a premium gas, but that Crosley recommends premium oil because the high speed of the motor causes frothing in standard oils. Asked about graphite in oil, he admitted he had no scientific data to back his mental feeling, but "If I am driving a car that has graphite in the oil and I lose all oil pressure, I still drive home; if the oil didn't have graphite in it, I would take the train home."

The long argument on this subject finally ended when H. L. Elfner of International Harvester Co. told a story about a young boy in 1913 who was trying his best to beat the time on piece work on a single spindle drill press. The drill press bearing kept freezing on the job, because of lack of continuous oil flow, and after many such hold-ups there was a breakdown. The boy asked the machinery man what could be done . . . he drilled the oil hole out a little, sprinkled a little graphite into the hole, and the drill press never broke down again.



Wagner Electric Corp. was dinner host to members and guests of St. Louis Section, March 11. G. A. Waters, vice-president, welcomed members after dinner in the corporation's new cafeteria, and described the plant's operation. Production problems were briefly discussed by C. W. Hesse, general superintendent. A group of the membership is shown here inspecting exhibits before dinner

## Annual Cleveland-Section-Sponsored Student Meeting Gives Young Engineers a Glimpse of Future Opportunities



by WILSON B. FISKE, Field Editor  
CLEVELAND Section, March 19—"Future Opportunities for Young Graduate Engineers" was the theme of the annual student dinner meeting held at the Cleveland Club under sponsorship of the Cleveland Section. Featuring a panel of experienced engineers from various local organizations, the meeting provided first-hand information for students soon to be seeking employment in their chosen field.

Over 125 students of Case School of Applied Science and Fenn College, faculty members of the two institutions, and Cleveland Section members sat down for a chicken dinner at 6:30 p.m. An evening of good fellowship and practical discussions followed.

George Tanker, chairman of Student Activities, welcomed the men of Fenn and Case and presided at the enlightening after-dinner session. He introduced R. F. Steeneck, Cleveland Section secretary, who presented the chairmen of Case and Fenn student groups with new student pins for the respective memberships.

A high point of the evening was the presentation of awards to winners in the essay contest sponsored by the Cleveland Section. Participants were Case and Fenn engineering students. Robert Sharp, Case junior, received the first prize of \$25 and an engraved certificate for his paper titled "Drill Jig Design." Bernard Weiczorek, Case senior, won an honorable mention certificate for his paper on "Aircraft Booster Pumps." The committee of judges was composed of George Tanker of The Weatherhead Co., Henry Luetkemeyer of the Cleveland Graphite Bronze Co., Norman Hoertz of Thompson Products, Inc., and George Hufferd of The Weatherhead Co. Tanker made the presentations. Award certificates were donated by Donald

Robert Sharp of Case, winner of the essay contest, and George Hufferd, chairman of Cleveland Section's Placement Committee

Smellie of The Hoover Co., North Canton, Ohio.

Main purpose of the meeting from a service standpoint was embodied in the panel discussion, featuring the panel of five engineering experts. On the panel were A. T. Colwell, vice-president in charge of engineering, Thompson Products, Inc.; E. W. Greasle, employment manager, Warner & Swasey Co.; Art Hewitt, proprietor,

Ohio Screw Products Co.; Rudolph Bauhof, Ernst & Ernst; and E. R. Sharp, manager of the Cleveland Laboratory, NACA. The panel was also supported by members of the Governing Board of the Cleveland Section.

Each member of the panel talked briefly, explaining the type of engineering employment in his own firm and discussing engineering opportunities generally. The panel members indicated approximate salaries that students might expect in various engineering positions and discussed the duties and responsibilities connected with the various positions.

The short talks were followed by a lively question and answer period conducted on the order of "Information, Please." This period last an hour and twenty minutes. And at the conclusion of the meeting, students lingered to ask even more questions and to gather all information possible.

Questions asked concerned employment in foreign countries, age barriers, military credit, summer employment opportunities, split shifts, opportunities in moving from job to job, effect of extra-curricular work on employment chances, credit given for Army or Navy experience, significance of extra degrees, training programs, advancement patterns, and so on. All questions were answered fully by the panel and by volunteers of the Governing Board.

Students, faculty advisers, and guests were unanimous in their declaration that the meeting had been most helpful as well as enjoyable.

Mixed group of Fenn and Case engineering students at dinner



Panel of engineering experts at Cleveland Section student meeting. Left to right: A. T. Colwell, Thompson Products, Inc.; E. W. Greasle, Warner & Swasey Co.; Art Hewitt, Ohio Screw Products Co.; Rudolph Bauhof, Ernst & Ernst; and E. R. Sharp, NACA



## SCHRODT

.... of British Columbia

Phil J. Schrodtt is British Columbia Group's first chairman. He gets most of the credit for the Group's formation last year. Besides, he is the man who keeps the big rubber-tired fleets of the B. C. Electric Railway Co. and B. C. Motor Transportation rolling. Amiable, long-legged and able Schrodtt is a veteran on SAE membership roles. And he's about the busiest automotive engineer in Canada's Pacific Province ... except in duck shooting season!

When the season for anything that "flies in the air but elephants" is officially opened, truck and bus maintainer Schrodtt leaves a note for his boss (when he doesn't take him along), bids his wife and two children fond good-



Phil J. Schrodtt

byes, and is gone for the swamps.

BCMT Mechanical Superintendent Schrodtt has been a resident of Vancouver off and on since 1910. Add a few years with Uncle Sam's air forces on the Mexican border, apprenticeship in Vancouver's Burrard Iron Works, additional training in the same field in Seattle, experience on Standard Imperial and Atlas gas engines, a ticket from Oregon State College, night foremanship for a pioneer B. C. motorcoach line - and this young man with two decades of service with bus-operating B. C. Motor can easily qualify as one of the leading highway transport troubleshooters in the entire Pacific Northwest.

War and parts and equipment problems added a few gray hairs to Phil Schrodtt's head. Formation of the B. C. Group added a few more. And now, with the B. C. Motor fleet constantly increased, Schrodtt is busy briefing for yet another responsibility. Trackless trolley coaches will make their initial appearance this summer on Canada's Pacific coast.

- by J. B. Tompkins, Field Editor



## RELLER

.... of Twin City

Carl R. Reller has worked hard for Twin City Section. He has been treasurer, secretary, vice-chairman and now chairman since its organization as a Group in 1943.

Reller is a native of Nebraska. He went to the state University, where he took a spirited part in athletics, was a track star and got his letter in cross-country.

He started work for Minneapolis-Moline Power Implement Co. immediately after taking his BS degree in 1930. His first order was to develop a complete line of natural gas burning engines. The work was car-



Carl R. Reller

ried on over several years, much of it in cooperation with Texas A&M.

This project completed, he did field development work for about four years - supervising development, erection, and testing of agricultural implements in the field.

In 1936 he was put in complete charge of the experimental laboratory, and three years later was running all experimental work, laboratory and field testing and research development. During the war he tested such items as the Minneapolis-Moline Jeep and the 6x6 Prime Mover built for the Army and Navy.

Reller lives in Minneapolis with his wife and two children. But he spends free time on a large farm in Nebraska, indulging his favorite hobby. Stamp collecting and fishing are secondary to his first love of growing things.

- by Hamilton Lufkin, Field Editor

## TRUSLOW

.... of Virginia

Things that attract the ordinary mortal leave H. B. Truslow, chairman of the Virginia Group, cold. Even the cacophony of V-J Day celebrations in the capital of the Old Dominion failed to bend his elbow, but lucky indeed are his friends who are invited by the chairman and his charming wife to partake of out-of-season delicacies from their deep freeze.

His business and his family constitute his hobby. Rumor has it that a master parts catalog disappears from the main branch of his Richmond Auto Parts Co. and returns again only when he has completed vacations at Virginia Beach.

Considered an authority on engine rebuilding, H. B. has made a name for his organization through liberally rewarding those who show interest in their work. He encourages employees to broaden their knowledge of maintenance through vocational and correspondence schools. Employees enjoy two or three outings a year, and Truslow shows deep personal interest in everyone who has helped to make his business so successful.

An officer in several jobber organizations, he is also active in the Kiwanis



H. B. Truslow

and does much to better the lot of the underprivileged. His mind dwells on more constructive things than stories with which the undersigned regales any group at any time. He's not even intrigued by African Golf - but we all like him.

- by Jean Y. Ray, Field Editor

This is the eighth installment in a series of biographies of 1946-47 SAE Section chairmen. Next month three more field editors will report on their Section chairmen.

## Versatile Fuel Test Equipment Described

by R. W. DONAHUE, Field Editor

PHILADELPHIA Section, March 12 - Described by Technical Chairman A. Ludlow Clayden as "possibly one of those significant events in technological history," a paper on "The Elimination of Combustion Knock" was presented before this Section by E. M. Barber of the Texas Co. Before one of the Section's largest audiences, Barber, co-author of the paper with J. B. Malin of Texas Co. and J. J. Mikita of E. I. duPont de Nemours & Co., Inc., described the development of an internal combustion engine process which is capable of digesting the complete range of octane and cetane number fuels. In addition to its indifference to octane and cetane quality, the process has been shown to operate successfully on fuels of various volatilities and preignition resistances.

In describing the Texaco Combustion Process, Barber briefly traced the origin of knock in internal combustion engines. In the case of spark ignition engine knock and preignition, he said, fuel ignition quality requirements result from tendency for spontaneous ignition to occur. In diesels, knock results from a delay in the occurrence of spontaneous ignition. In both cases, spontaneous ignition occurs as a result of the residence of combustion air-fuel vapor mixture for some finite time at combustion-chamber temperatures and pressures. Barber and his co-workers developed their process with the purpose of reducing the residence time of the mixture in the cylinder.

In a series of colored slides, Barber showed schematically the introduction of fuel into the combustion chamber through an injection nozzle into a directed swirl of air such that a combustible mixture was formed in a limited zone only. This increment of combustible mixture moves past the spark plug, is ignited, and is continuously replaced by new increments of combustible mixture until all air is consumed. Thus the idea of reducing residence time of the fuel and air mixture in the cylinder is accomplished. Barber pointed out that the combustion timing in this process depends jointly on the injection timing and the spark timing. For a given injection timing, it is possible to vary the spark timing over the "spark tolerance" range. This range varies for each injection timing.

Most of the work reported has been done in a single-cylinder CFR engine. Operating conditions were varied over a wide range. Compression ratios ranged from 6- to 11-1, with normal operation at 10-1. Manifold pressures were varied from 10 to 120 in. of hg abs; speed from 200 to 3600 rpm;

jacket temperatures from 212 F to 375 F; and mixture temperatures from 90 F to 400 F.

In response to a question, Barber reported that the process has been shown to be very flexible in operation, being capable of going from no load to full load and vice versa with no difficulty. Further questions revealed that the development is continuing, with consideration given to the application of the process to two-cycle operation.

## Modern Methods Told At T&M Panel Session

by CHARLES FOELL, Field Editor

METROPOLITAN Section, April 3—More than 80 fleet operating and maintenance engineers were given the inside story of modern maintenance methods at a vigorous T & M Panel Meeting when ills of electrical systems, carburetors and engine components were diagnosed by three specialists.

Frank Macy, the Durham Co., went to the seat of generator, regulator and battery troubles, and came up with the conclusion that an ounce of prevention would save the fleet operator many dollars of costly repair work.

Source of most trouble, he said, was the common error of overloading the generators—asking them to produce more than they should, under the poorest operating conditions of dirt, grease and heat. Electricity is always right, Macy said, it is the application and usage that is wrong. The spotlessly clean, ideal operation of a power house generator was cited as the direct opposite of automotive conditions.

Discussing carburetor design and operating ills, E. D. O'Reilly, Stromberg Carburetor Division, has found that most of the carburetion troubles suffered by the fleet engineer stem from incorrect knowledge of the functioning of the carburetor itself. Most so called repairmen tried to blame a carburetor for all motor ills—to find out too late that compression or ignition was at fault. As an example of incorrect knowledge, O'Reilly offered the common error of installing adjustable metering jet to try and accomplish what only one very precise factory setting can accomplish.

Third man of the all-star team, introduced by William R. Cubbins, Jr., chairman of the Panel Meeting, was Joseph A. Doyle, who recently returned to Sun Oil Co. after service in the U. S. Army overseas as a colonel.

"Know how" and proper instrumentation are essential if the operator of a fleet of vehicles is to keep his equipment running and earning a profit, Doyle said.

He described a step-by-step procedure, based on a technique whereby malfunctioning is broken down into three major categories: compression, ignition and carburetion.

These tests are arranged in a sequence whereby trouble is determined by the process of elimination in which series the most prevalent ills are tested for first.

As a result of this arrangement, many of the later tests in each series often do not need to be made, inasmuch as the trouble is quickly located.

Instruments properly designed require an understanding operator. But a little careful training on a long-tested procedure will save time and money in the long run, Doyle said.

## THIS IS A JOB FOR..



# VENTALARM

Ever try putting a size-5 shoe on a size-10 foot? It's comparable to filling the majority of gas tanks, using modern pumping equipment, without spillage.

To be safe and efficient, today's gas tank must offer these vital advantages:

- Ability to fill—without blow-back—at modern commercial pumping speed—substantially 15 gallons per minute • Positive warning when the tank is properly full • A safety zone, to eliminate spillage due to expansion from temperature rise • A filler-neck that provides sub-surface filling—thus preventing evaporation during filling.

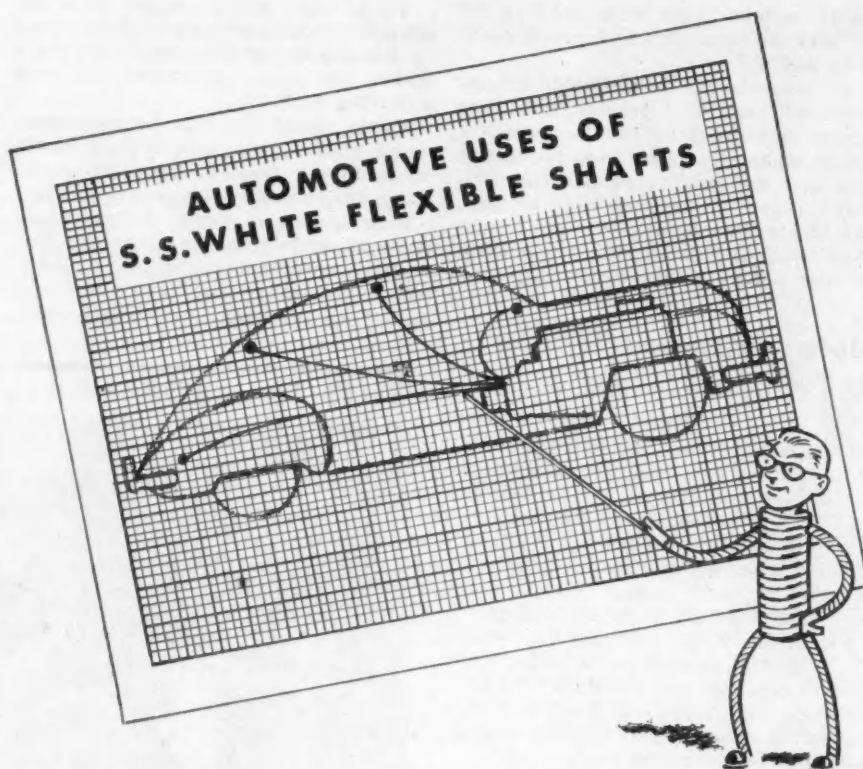
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## Heavy Trucking Grows Despite Legal Limits

by J. B. TOMPKINS, Field Editor

BRITISH COLUMBIA Group, March 12—More power, better brakes on lighter and cheaper trucks were listed as the number one "wants" of the commercial trucking industry on the Pacific Coast by R. C. Norrie, chief engineer of the Kenworth Motor Truck Corp., at this meeting. Though, because of load and size limitations on Canadian highways, large Kenworth trucks are confined largely to the private roads of the logging industry in British Columbia, engineer Norrie said that heavy trucking is rapidly "coming into its own."

"The worst evil the highway transportation industry has to contend with, however, is its nuisance to the private motorist," he warned his Canadian listeners. "Heavy trucks laboring up steep grades and bottlenecking traffic breed restrictive legislation."

War, Norrie recalled, sparkplugged the lifting of load limits in certain states. But more important, he stressed, the emergency's demand for more power and larger loads had brought about better motor design, increased horsepower, lowered weight per horsepower and improved cooling. Transmissions, too, he claimed, were improved and redesigned, with the torque capacity in some upped as much as 20%.

In heavy truck design, he warned, steering mechanisms have been pushed "fairly well to their limit" without the addition of boosters. Front axle troubles he laid to speed rates rather than engineering. In construction of Kenworth equipment, he claimed use of pressed steel housings for rear axles had been found best.

While discussing the use of lightweight alloys, Norrie passed a section of aluminum alloy extrusion among his audience. Aluminum, he explained, was being used extensively in all Kenworth highway models for transporting commodities ranging from hay to beer and general freight. Little is used, however, in heavy logging units, since, unlike highway carriers, they are not weighted to conform with state load limit standards.

Weight savings in highway models through the use of aluminum for side-rails he listed as some 27%—typical, he said, of savings made throughout the vehicle by aluminum use for castings. Though he claimed some 200 lb could be saved by the use of the light metal for rear axle housings (as in a Timken model), Norrie said the saving was small in comparison with the total weight of the vehicle. In this instance, he claimed, rigidity was needed more than lightness.

Used in hubs, however, aluminum

saves some 55% in weight; in brake shoes the saving is 50%.

In the discussion and question period following Norrie's address, he claimed the electric energy dissipator was "pretty much" in the experimental stages. . . . actually it is only an electric motor operating in reverse and creating a "disturbance" to act as a booster to the brakes. It won't, he claimed, provide a "complete stop" but merely "give aid" on hills.

Motor bearings, he replied in answer to one member of the B. C. group, are being improved. Replying to another query, he claimed a preference for worm drive as compared with double reduction drives. The worm type, is simple, he said; has fewer adjustments and has fewer parts to "work loose." The worm drive does "a good job" anywhere, he concluded.

Hosts to the meeting were Vancouver's Ferguson Truck & Equipment Co., Ltd.—British Columbia distributors for Kenworth trucks.

## Labor Economist Examines Policy

by W. F. SHERMAN, Field Editor

DETROIT Section, March 24—"The people of America must retrace their steps in labor policy to correct mistakes of the past ten years and avert a widening of Government regulations," declared Dr. Leo Wolman, professor of economics, Columbia University, addressing the Detroit Section at the Hotel Statler. Approximately 500 members and guests heard the noted labor economist in his discussion of "The Next Steps in Labor Policy."

The consequences of labor policy run deep, Wolman declared. Labor policy affects not only a limited range of specific issues such as wages, seniority and the closed shop. In the long run it may well determine how the economic and political life of society is organized. And that, as everyone can see, is a decision of first importance to the people of the United States.

Wolman described the impact of the decision made in the early 1930's when we embarked on a national policy—a "crusade"—to unionize everybody. Today some 150 or 200 national unions dominate the labor policies of our basic economic activities such as steel-making, transportation, mining and construction. The pressure is great to unionize every group, including professional men, engineers and even management. The effect of the unionization itself on such a broad scale is to reduce the job opportunities by making it impossible to freely select employment.

"The national unions are strong enough to have their way," he said. "They have already lifted the level of costs and introduced restrictions and

inflexibility into the economic system."

Wolman outlined two alternatives which we may choose in America:

First is to accept existing conditions and trends in labor relations which further strengthen organized labor. This sanctions large scale national monopoly and invites progressive state intervention into the affairs of both business and organized labor.

Second alternative is to retrace our steps in labor policy, to enact corrective labor legislation and to follow administrative policies which will put

unions under the law, expose them to competition, and thus loosen their monopolistic hold on industry and labor.

He characterized labor relations in this country as "practiced on a nervous basis" and one that is not conducive to improved labor relations.

Our mistakes in national policy are not unique, he pointed out. An example is that in England three years ago the book "Full Employment" by Sir William Beveridge was characterized as the most significant in 50



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years. Today the words are not mentioned. There is full employment, but not enough production, and some Englishmen might even exchange the 1937 condition of millions unemployed but plentiful supplies for today's reversal.

Wolman, prominent in Government boards and agencies during the years of the "crusade," declared that it was never the intention of Congress to force everyone into union organizations but referred to a recent proposal by Fiorello LaGuardia to establish

four big union organizations to run all of the economic system. He characterized this as a duplication of the Italian corporate state—"a great myth, and a great failure."

Yet only in Russia has our "joining rate" been exceeded, he declared.

Transcending the need for peace is the need for democracy, Wolman said, pointing out that there are formulas for enforcing peace which no American would choose because they mean dictatorship. He said that our next steps in labor policy should be those

which preserve our liberties and base our economic organization on individual merit, rather than the recent trend to Government control and a perpetual class struggle.

"What did we do to get in this fix?" Wolman asked. "We passed some laws and set up some agencies," was his answer. Necessary for a satisfactory adjustment is action by Congress: (1) to clarify the laws, (2) to deal with monopolies such as unions have become, (3) to keep the peace and avoid the kind of violence where massed pickets range through towns with clubs, and (4) to require some standards of decency among the union organizations.

Clarification needed includes re-writing of the Wagner Act to state clearly whether foremen may be organized into unions, steps to remove the "muzzle" from employers, and new language in the Fair Labor Standards Act to avoid repetition of things like the "portal-to-portal" bonanza.

"Will that settle the labor troubles?" Wolman asked, and answered, "No!" He said that all that we can do is minimize the troubles and see to it that our economic system has two well-guarded fundamentals maintained in it:

First, flexibility—room to turn around because circumstances have changed, to change your costs, and to remold your business; and second, a system that can throw off a surplus when times are good, or "put things aside" for the future.

He closed saying, "We were a reckless people when we set out on a path that would destroy our economic system . . . a lot of good it does to have a humanitarian employer if he can't make enough money to keep the business operating. A union leader who yells against profits and wants to take all profits away from business today is rendering a disservice to his own members."

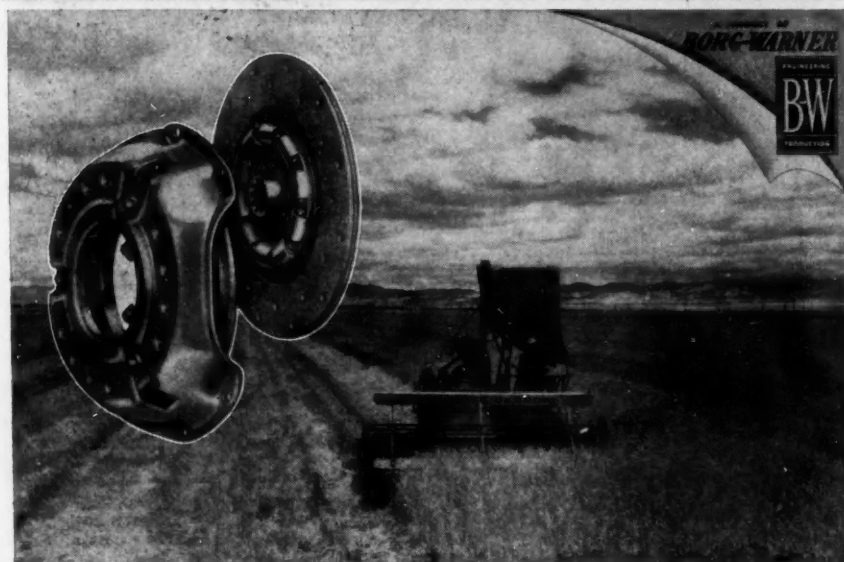
Wolman was introduced by Frank Rising, general manager, Automotive & Aviation Parts Manufacturers, Inc., and V. C. Young, chairman of the Detroit Section, presided at the meeting.

## Safety Engineering Cuts Insurance Cost

by ARNOLD R. OKURO, Field Editor  
NEW ENGLAND Section, March 11—Insurance is little different from any other business, Arthur D. Cronin told this meeting, except that manufactured cost is, instead, loss cost, and is controlled not by the seller but by the buyer. For this reason the only way in which cost can be reduced is by buyer cooperation in reducing loss.

Individual buyers of automobile insurance can help reduce cost by a con-

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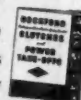
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Downward trends in loss ratios, Cronin said, have proved the efficacy of concentrated attention and the cooperation of the assured.

## Light Planes, Turbos On Aircraft Program

by R. W. BIXLER, Field Editor

SOUTHERN CALIFORNIA Section, Feb. 6—Two papers highlighted this Section's aircraft powerplant engineering meeting at the Biltmore Hotel: "Design Trends in Turbojet and Turboprop Aircraft Engines," by Earl V. Farrar, manager of Wright Aeronautical Corp.'s Gas Turbine Division, and "Powerplant Requirements for Personal Aircraft," by Peter Altman, consulting engineer.

Farrar presented a running description of gas turbines from the "Smokejack" through one of the most powerful turbojets in this country—General Electric's TG-180.

Smokejack was a "chimney" turbine designed to turn a spit for roasting meat. Leonardo da Vinci suggested the idea in 1550, and a model was built some time in the Seventeenth Century. The TG-180, on the other hand, consists of an axial flow compressor, can-type combustion chambers, and a fixed-area exhaust nozzle. Its thrust power at transonic speeds is approximately equivalent to the combined power of 75 modern automobiles. This engine is being used to power the Douglas D-558 "Skystreak," which is to be used as a flying laboratory in exploring the transonic speed range.

Both the axial-flow and centrifugal-type compressors, Farrar said, have been used with success. Advantages of the centrifugal type are extreme ruggedness and no measurable loss of performance from accumulation of dirt in the passages. Advantages of the axial-flow type are a higher peak efficiency and smaller diameter . . . its disadvantages are the relatively fragile structure, easily damaged when foreign particles enter, and deterioration in performance from an accumulation of dirt in the blading. Farrar believes, however, that the axial-flow type will be used to a practical extent in a few

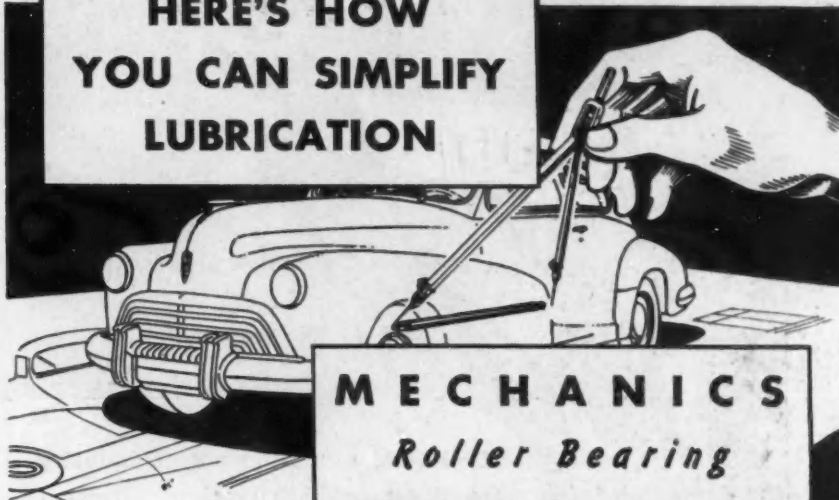
years when the disadvantages have been overcome.

Variable area exhaust nozzles are not generally used either in the United States or England, he said, because of difficulties presented by the extreme heat encountered. Use of a variable area permits adjustment of the jet velocity to obtain minimum fuel consumption and maximum thrust as desired under various conditions of flight. It is felt that the design difficulties will be overcome and this device applied to turbojets of the future.

Turboprop seems to have few advantages over the turbojet other than permitting bends in the exhaust system. It presents problems in air intake, which is obstructed by the presence of a reduction gear and propeller, in the means of mounting the engine, and in its requirement of lubrication for the reduction gear, causing greater oil consumption.

Altman's paper was based on a survey made for Continental Motors Corp. to determine the probable market for personal planes during the next 5-10

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years, and to obtain powerplant requirements for those planes. A few of the "majority" preferences of aircraft builders reported were:

Power range . . . 80-90 hp at 2300 rpm for 2-place planes; 100-130 hp at 2300 rpm for 3-place planes; over 150 hp at 2300 rpm for 4-place moderate-priced planes; and 220-250 hp at 2300 rpm for 4- or 5-place deluxe planes.

Cylinder arrangement . . . aircooled flat opposed type engine.

Number of cylinders . . . 4 cyl for smaller aircraft or 6 cyl if weight and

price can be kept down; 6 cyl for 4- and 5-place planes.

Fuel system . . . 80 octane rating; rear location for fuel pump; operation on premium automobile fuel if possible; injector preferred over carburetor; easy starting at 10 F; accelerator pump and air filter.

Oil system . . . wet sump; sump and oil system permitting a 20-deg climb and 20-deg glide; oil filter; location of crankcase breather at rear of engine.

Starter . . . 12-v system automotive-type starter; simple foot control.

Superchargers . . . optional.

It was suggested that gas turbine powerplants would be considered if they could be designed to develop about 300 hp with a fuel consumption up to 0.6 lb per bhp per hr, a weight (including starter) of 150 lb, and a price of approximately \$1500.

## Hear Three Facets Of Turbine Design

by GEORGE W. BAUGHMAN, Field Editor

WICHITA Section, April 10—Two papers and an impromptu talk brought gas turbines, propellers and materials to this Section's attention tonight.

W. W. Williams of Beech Aircraft Corp. introduced the subject "Gas Turbines for Aircraft" with a brief description of the historical development of the larger turbines.

Four small low-powered gas turbines are now in use on military aircraft. While not yet adaptable for personal airplanes or feederliners, the speaker said, small engines are feasible for such service. He showed that dollars per hour, not pounds of fuel consumed per hour, is the true criterion of turbine economy.

Analysis of a twin-engine plane weighing 9250 lb gross operating for 4 hr showed that a gas turbine combination would save as much as 400 lb weight, and operate for \$7.00 less in fuel consumption at cruising speed than a reciprocating engine installation in the same plane.

Williams estimated that it would cost between \$300,000 and \$500,000 to develop a 100-hp geared propjet. He believes axial flow turbines will prove cheaper and more practical than centrifugal flow.

Propellers on gas turbines present special problems of control. John Lesener, installation engineer of Hamilton Standard Propeller Co., pointed out that propeller and turbine rpm must be closely controlled to avoid serious overspeeding of the turbine. Fuel flow and propeller control must be closely coordinated. A turbine with separate compressor, he said, is easier to control than integral compressor turbines.

Another serious problem faced by propeller manufacturers is the extremely high negative thrust on a windmilling turbine propeller. It has been shown to be far in excess of the maximum positive full power thrust of the propeller. Large turbines required 200 to 300 hp to bring the engine up to sufficient speed to start the turbine. Under these conditions, propellers must have a minimum torque setting . . . and another problem arises. Proposed as feasible were 2-speed engine propeller combinations capable of attaining high efficiencies under both take-off and cruising conditions. Propellers are expected to grow considerably for future engines.

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Howard A. Smith, metallurgist of Beech Aircraft Corp. discussed alloys and fabrication processes suitable for turbines, in a paper entitled "Brazing for High Temperature Service in Gas Turbines, Rocket Motors, and Exhaust Nozzles." Smith said that although high temperature alloys date back to the first World War, it was not until 1930 that commercial steel mill practice could produce in quantity.

was generally agreed that a single electrical system would be best if its disadvantages could be eliminated.

For instance, it was pointed out that electrical devices are not too successful where rapid operation is necessary—although another discussor contributed the thought that often there is a way of getting around this slowness. Weight must also be lowered, and in this connection, aluminum was mentioned as a replacement for copper in wires, but a light substitute for the iron in the magnetic circuit has not yet been found.

Improvements in speed and reliability are also being brought nearer to reality by night-flying cargo planes to transport freight anywhere in the United States.

Smart engineering, operation, and management will be necessary, the speaker said, for above all, the service must be extremely flexible.

Studies of applied anatomy, physiology, and kinesiology (or the science of physical movement) were recommended as helpful in solving one of mankind's oldest problems, seating

## Aero Meeting

cont. from p. 23

and surveillance aid. Thus the problem reduces itself, it appeared agreed, to the question not of "which system" but rather of how to obtain immediate installation of both at all airports.

To gain most benefit from any landing system, it was emphasized that it must be used religiously in good weather until it becomes routine. Then it will be used as a matter of course in bad weather.

Further aids to reliability and safety are automatic controls that were said to be able to handle engine, flight, navigation, and even traffic control better than human beings, and without fatigue or error. It was pointed out, however, that such controls must in themselves be of the utmost reliability.

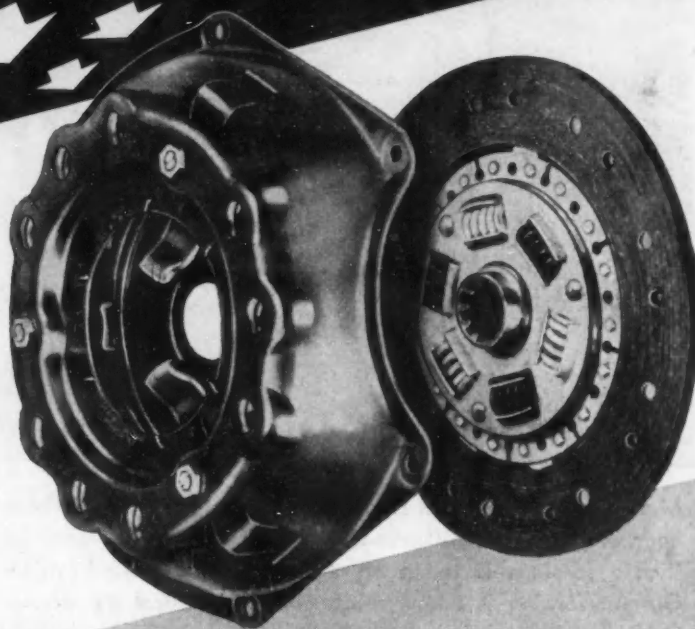
There was a difference of opinion as to the desirability of mechanical overrides on all controls that could be used in case of failure. Pilots in military service don't want them, for, they argue, if manual controls are provided, why have the automatic ones as well. In any event, they are of no help in subsonic flight. It was suggested that a better solution to the latter problem would be to provide duplicate controls for the complete system.

Safety needs are also being advanced by the new CAA regulations governing performance requirements for transport planes. Some of the complexity can be removed from these regulations by using a system of charts which were said to be capable of indicating trends and relative performance of one design with respect to another. It was agreed, however, that such charts must be taken with the proverbial grain of salt, for they make no distinction between good and bad design. As one engineer put it, "The charts show what can't be done if you don't try very hard."

The old controversy of electrical versus hydraulic systems was touched off by a paper that discussed the advantages of the electrical system, and ended by the addition of an exponent for the pneumatic system, who pointed out that air has the advantage of being nonflammable and of little weight. It

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comfort, currently aggravated by the elimination of sleeping berths that has come with higher speeds.

The design of a seat that is adjustable to accommodate the various human sizes and shapes, that allows comfort in eating, sleeping, and just sitting in a relaxed position was reported to be no simple task.

Proposal was made for an adjustable chair with a moderately fluffy pillow, a back rest to provide best average back support, seat height of 17 in., seat width of 20 in., curved front line on the seat, and adjustable arm rests.

## New Members Qualified

These applicants who have qualified for admission to the Society have been welcomed into membership between March 10, 1947, and April 10, 1947.

The various grades of membership are indicated by: (M) Member; (A) Associate Member; (J) Junior; (Aff.) Affiliate Member; (SM) Service Member; (FM) Foreign Member.

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**Milwaukee Section:** James Arnold Hunter, Jr. (J), William Richard Proteau (J).

**Mohawk-Hudson Group:** William Bronk Shepherd (A).

**New England Section:** John W. Hess (A), John W. McGoey (M), Harold E. Sandberg (A).

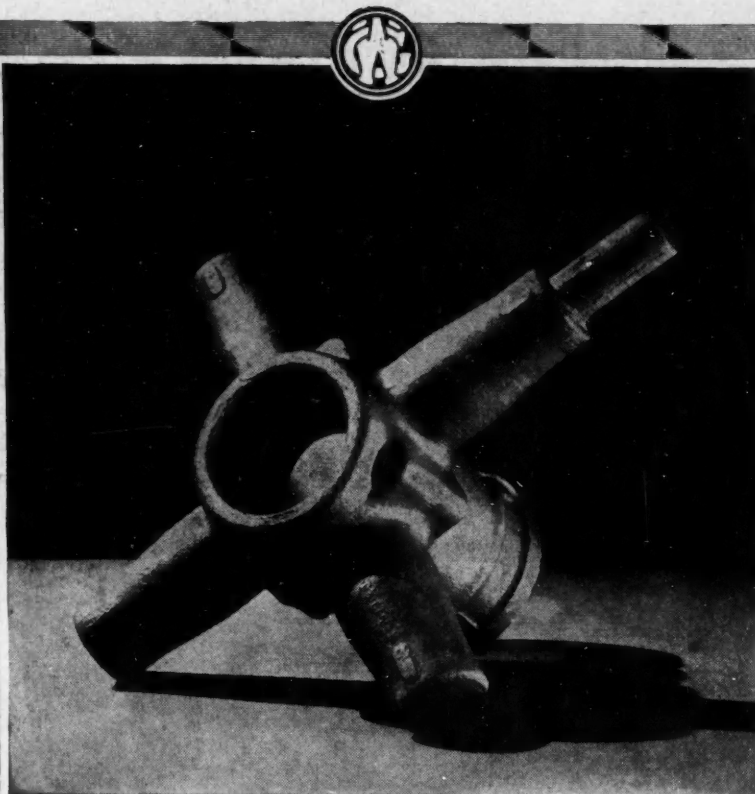
**Northern California Section:** Capt. Arthur L. Daun (SM), Edward C. Ditzen (M).

**Northwest Section:** Runo W. Larson (A), F. R. West (A).

**Peoria Section:** John Webster Gilbert (J).

**Philadelphia Section:** Frank G. Birkhead (M), William H. Bulen (J), William P. Dugan (J), William H. Heermance (M), Marion F. Smith (M).

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Foreign: W. Leslie Cuthbert (A), B.W.I.; Dr. Jaroslav Frei (F M), Czechoslovakia; James A. Hand (A), China; Mahmut Velit Isfendiyar (J), Turkey; Lt. Col. William S. Lawrence (S M), South America.

Herbert Moore, Harold C. Thomas, S. Arthur C. Witten.

Chicago Section: Paul C. Baker, John P. Buck, George H. Daskal, Jr., Robert Frank Ettinger, Ralph D. Feick, Frederick Thomas Finnigan, James Roy Haynes, Cloyd L. Lawrence, Raymore D. MacDonald, John Allan MacLean, Ronald Walter McIntyre Elton F. Nichols, Herman G. Portman, Jr., F. A. Ronzheimer, Edwin Warder Tanquary, Lohde C. Tesch, John E. Thompson, James F. Sprague, Arthur J. Sturwold.

Cincinnati Section: George E. Rice.

Cleveland Section: Merrill G. Beck, Paul L. Cairns, Lee Cirillo, William B. Hargadon, Elmer A. Kemp, Carl F. Koenig, Edward H. Lisowski, John E. Rowe, William H. Rowe, Kurt R. Weise.

Dayton Section: Robert L. Fritsch.

Detroit Section: William R. Benk, Jr., Alphonse W. Berard, George T. Christopher, H. Dean Clark, Ramkrishna Ganesh Damle, Bernard F. Fountain, Oliver S. French, Albert W. Gair,

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## Applications Received

The applications for membership received between March 10, 1947, and April 10, 1947, are listed below. The members of the Society are urged to send any pertinent information with regard to those listed which the Council should have for consideration prior to their election. It is requested that such communications from members be sent promptly.

British Columbia Group: Robert McKenzie Adamson, Guy Barclay, Pat J. Conlin, Arthur Fred Rees, Standard Oil Co. of British Columbia, Ltd.

Buffalo Section: Harry C. Oakes, Jr., Peter Tauson, Chester M. White.

Canadian Section: Frank Wakefield Adams, Thomas Edmond Bingham, William Hugh Cockburn, Walter Dale, Arthur William Frazer, Jr., Mansell

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Hawaii Section: Moses M. Ahuna, William F. Smarz.

Indiana Section: Albert E. Frye, Thomas V. Heffernan, Walter E. Johnson, E. Crowell Knight.

Kansas City Section: John E. Cox, Jack W. Dees.

Metropolitan Section: Frank E. Bremer, Martin F. Christensen, Robert E. Coleman, Keith N. Crowell, Ben R. Czyewski, Niilo V. Hakala, George O. Hiers, Paul Louis Hlesciak, Robert James Jackson, Rolland R. King, Ernest Lagelbauer, M. V. Littel, Howard I. Margerum, Andrew V. Martin, James T.

Murphy, Kjell O. Nilsson, Frank N. Pagano, Jr., Rudolph Seidl, Robert L. Stallard, Paul E. Weingart.

Milwaukee Section: George Y. Anderson, Jr., Herbert A. Guntow.

Mohawk-Hudson Group: Arthur J. Rose, Gilbert S. Sullivan.

New England Section: Robert Gilman Ballard, Richard B. Harvey, Everett Malcolm Johnson, John B. Perkins, Robert Allerton Frisch, Frank Sorbera, John J. Spadaro.

Northern California Section: Forest Winton Fingerle, John J. Meyer.

Northwest Section: Stuart J. McTaggart, Gerhard G. Ruben.

Oregon Section: John William Cannon.

Peoria Section: Harold W. Jeter, Karl J. Mogk, Harlow H. Piper.

Philadelphia Section: Ernest Fowler Marshall, George W. Marshall, Jr., H. Barker McCormick, Jr., Charles P. Orr, Paul H. H. Snyder, Miles Seymour Trumble.

Pittsburgh Section: Floyd F. Curtin, Daniel Durie, Thomas M. McBroom, Charles Rallya Scott.

St. Louis Section: Niels C. Beck, Alex N. Swargulski.

Southern California Section: Bennie G. Ayala, Gustav A. Delph, William Glenn Ebersole, W. J. Elgar, Frederick Hammond Green, Kingdon Kerr, Glynn H. Lockwood, George McLaren, Otto A. Scholz, David Edwin Weber, Edward F. Weiss, Ralph H. Zimmerman.

Southern New England Section: Roland Kenneth Blakeslee, S. Herbert Hillebee, Jr.

Spokane Group: Keith W. Tantlinger.

Syracuse Section: David Templar Doman, James C. Wilson.

Texas Section: H. M. Fox, Hugh L. Jacobs.

Virginia Group: Earle Randolph Cournow, Malcolm J. Gowen, Albert G. Griffin, Randolph Peyton Saunders.

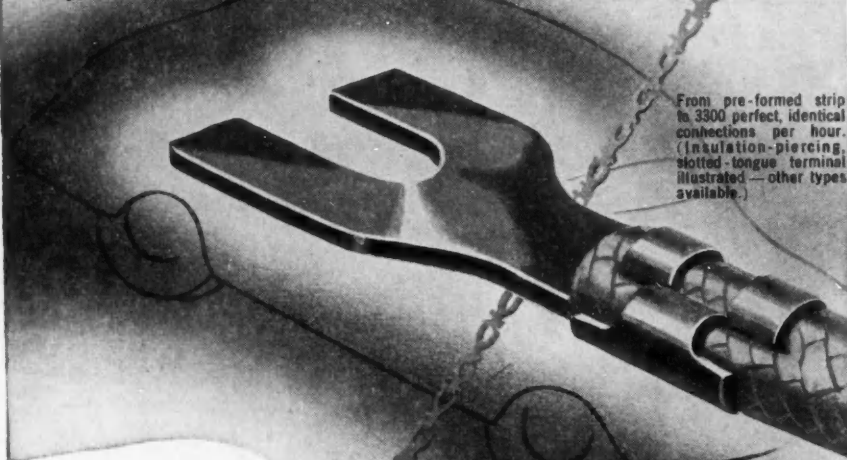
Wichita Section: Harold W. Zipp, Richard N. Cooper, Wayne Millar Smith.

Williamsport Group: Robert H. Ammon.

Outside of Section Territory: K. W. Andersen, Mando S. Ariens, Bernard C. Press, Walter Burke Starks, Allen O. Tilton, Brig-Gen. Gordon M. Wells, A. G. Wyrick.

Foreign: C. W. L. Bailly, England; William Read Bendall, England; James Foster Dunwiddie, Japan; Ing. Dr. Vsevolod Grecenko, Czechoslovakia; Ir. J. Hardonk, Holland; Raymond Louis Rene Lucas, France; Jean Pierre Marchal, France; G. Van Twist, Holland.

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